Established 1916 as
OIL WEEKLY

FEBRUARY 1, 1956

# WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING
PRODUCING OPERATIONS AND MANAGEMENT

Gulf Publishing Company

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- **CURRENT OUTLOOK —An accounting system for the smaller producer.**
- **DRILLING — The world's largest mobile rig.**
- **PRODUCTION — What to do about sucker rod failures.**
- **INTERNATIONAL — Exploration in Nigeria.**


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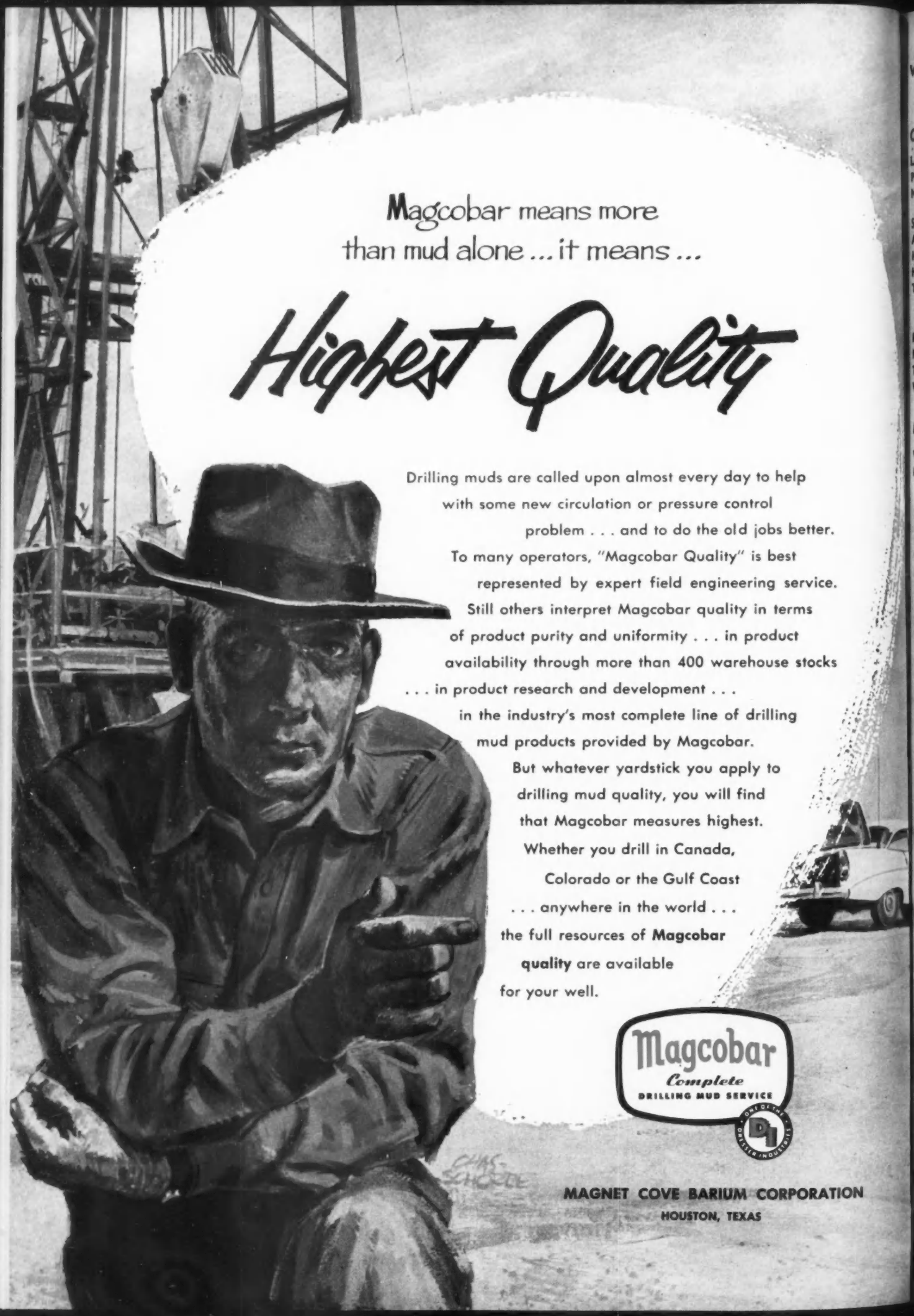

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Volume 142, No. 2 Feburary 1, 1956


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# WORLD OIL

Established 1916 as The OIL WEEKLY


# a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

## CURRENT OUTLOOK

☐ **Recent drilling activity** has enhanced the lower Paleozoic possibilities of the Catskill mountains area of Greene, Delaware and Ulster counties in New York State . . . within 100 miles of a ready potential gas market in New York City. A recent test, drilled to 6400 feet, has encountered a good show of gas and location has been made for a second test in the hope of encountering good Oriskany "Clinton" and Medina sand on the structure. Turn to **Page 40. Natural Gas Production 100 Miles from New York City?. . H. T. Brundage**

☐ **The voucher system of accounting** kept on the accrual basis has many advantages to offer the small producer. For an accounting system that is streamlined, efficient and simple, turn to **Page 43. Streamlined Accounting for the Small Producer. . . . Holiday Hayley**

☐ **How is atomic energy serving the oil industry?** Beginning on **Page 46** is an article that tells . . . radioactive materials and their detection are used in exploration, drilling, producing, transportation, refining, and research. The oil industry is the largest industrial user of radio-isotopes. You may be able to make some use of this new technology. **Atomic Energy Serves the Oil Industry. . . . . Allan C. Johnson**

**Turn the Page ▸**

## *a featured production article . . .*

☐ **How to avoid accidents and minimize hazards in well completions** and workover operations is told by an authority on the subject. Described in this article are some of the most frequent hazards and what can be done about them. Hazards in drill stem testing, removing tool joint plugs, dislodging cores, running production casing, handling tubing, displacing mud with oil, swabbing, acidizing, squeeze cementing, perforating, and hydrogen sulfide gas. Turn to **Page 138** for safety precautions that mean . . . **All's Well on This Flowing Well** ..... **K. H. Gibson**

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☐ **Burdened with details?** Are your top executives so overloaded with details that they are unable to concentrate upon executive planning? Here's how one company solved this problem by compromising between the functional and regional plans of organization, thus shifting responsibilities throughout the lower echelons. See **Page 50. How Lone Star Gas Passes Authority Down** ..... **M. L. Bird**

☐ **Avoidable absenteeism** among employes is caused to a considerable extent by conditions that can be controlled or influenced by management. Careful study of absenteeism by managers will shed some light on the causes involved. Knowing these causes, a manager can act to curb absenteeism. Turn to **Page 52. How To Increase Presenteeism**..... **Auren Uris**

☐ **Gulf Coast offshore development** is beginning to justify the heavy costs involved. Operators are still using red ink but hope to be "in the black" before long. More than 20 companies are now operating offshore. **Optimism Offshore**..... **Page 62**

☐ **Converted crude oil storage tanks** are helping to solve the problem of storing wheat in Oklahoma. This idea may point to a new method of using storage capacity in areas where tanks are no longer needed and where dismantling and hauling are uneconomical. **Oil Tanks Help Solve Wheat Storage Problem**.... **Page 64**

### EXPLORATION ARTICLES

☐ **Exploration of the Hugoton Embayment** has been stepped up during the past few years. A by-product of this concentrated effort is a different interpretation of certain exploratory bench marks. Turn to **Page 75** for an explanation of . . . **What the Hugoton Activity Means**..... **G. F. Thomas**

☐ **Recent developments in the prolific Osage County** of Oklahoma have caused a revival of this old area. Major oil companies are getting back into the play. For a geological history of the area that will help in evaluating the chances there, turn to **Page 85. Mississippian Production in the Osage**.... **J. A. Hayes, Jr.**

### DRILLING ARTICLES

☐ **What factors should be considered in slim hole drilling?** Beginning on **Page 91,** the limitations of the slim hole are considered with regards to depths, terrain, mobility, hole making ability, and economics. Don't miss this report on slim hole drilling considerations. **Slim Hole to Crowd Big Hole?**..... **G. C. MacDonald**

☐ **Will porous chrome surfacing improve wear resistance** for liners and bearings? The affinity of porous chrome for lubricants promises to effect tremendous savings by prolonging service life, reducing downtime and repairs, and minimizing replacement inventories. Read the article starting on **Page 98. Porous Chrome Plating for Wear Resistance**.... **Glenn Pendley**

☐ **Low solids drilling fluids** obtained by the mechanical separation of the heavy barites from the light weight drilled-solids is providing:

- Better viscosity control
- Decreased mud costs
- Improved penetration rates

A concise explanation of the work being done on low solids drilling fluids and the mechanical separation is described in the article beginning on **Page 102: Evolution of Low Solids Drilling Fluids**.... **Nash O. Campise**

☐ **Twelve wells will be drilled from one offshore platform,** which will serve later as a production platform. Here's a description of Shell Oil Com-

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

# Looking Ahead . . .

. . . **The U. S. economy currently is in a delicate and uneasy balance.** It is on a high plateau, to which it climbed in 1955. Business continues generally good. But it shows some weakening in certain lines. The boom may be passing its peak. No serious letdown is feared. But neither is there expected any repetition of last year's feverish increases in activity.

•

. . . **Some easing of governmental restraint on credit is occurring.** More relaxation is urged in some quarters. The series of increases in the discount rate in 1955 by the Federal Reserve Board has slowed the booms in residential construction and automobile purchases. Purpose of controls was to avoid a "boom and bust" cycle. Now there's some question if the existing credit restrictions are too tight. Because of a further drop in home building in December, the government recently restored 30 year loans. They had been cut to 25 years last July as an anti-inflationary move. Slight increases in down payments on homes, made last July, remain in effect. Harlow H. Curtice, General Motors Corporation president, recently declared that borrowing on cars is not excessive. He condemned FRB restrictions. Arbitrary tampering with money and credit is dangerous, he asserted. He expressed hope the government would go back to a normal policy of making credit free and available.

•

. . . **The oil industry is regarded by some as being in a preferred position.** Its volume of business is expected to increase 4 percent or so for 1956. Its prices are firm. The expected higher sales will more or less compensate for the increases in costs of materials and labor during the past year.

•

. . . **Good business in 1956 is generally expected by companies that supply the petroleum industry with equipment, materials and services.** There are expectations of higher demand for oils, somewhat increased crude production, and further expansion of plants and facilities. Based on these prospects, equipment suppliers hope to find increased demand for their goods. Drilling contractors hope to drill more wells and footage in both fields and wildcat areas.

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. . . **Only rough ideas are available so far as to the amounts of the wage raises to be sought by unionized oil industry workers in 1956.** Even rougher would be guesses as to any actual increases to be expected. O. A. Knight, president of the Oil, Chemical and Atomic Workers International Union, has declared that an increase of 50 cents an hour could be justified. But he conceded that locals probably would settle for 32 cents. Wages have been lagging behind growth of productivity for several years, he declared. And a raise of 13 percent or 32 cents an hour, he said, would cover only the 13 percent increase within the past year in productivity, as measured by refinery input per day of labor employed.

•

. . . **The new session of Congress has put the oil and gas industries on the defense in numerous legislative matters.** Late January was expected to bring either bare passage or bare defeat of the Harris-Fulbright bill. It would exempt gas producers from federal regulation. Protectors of the depletion allowance will have to fight once more against its reduction. More taxes on gasoline are threatened in proposed highway construction legislation. Committee hearings will delve into marketing and distribution. Investigations doubtless will be used for vote getting, at the expense of oil and other industries. Politicians will be especially solicitous of consumer's welfare and critical of business in this important election year.

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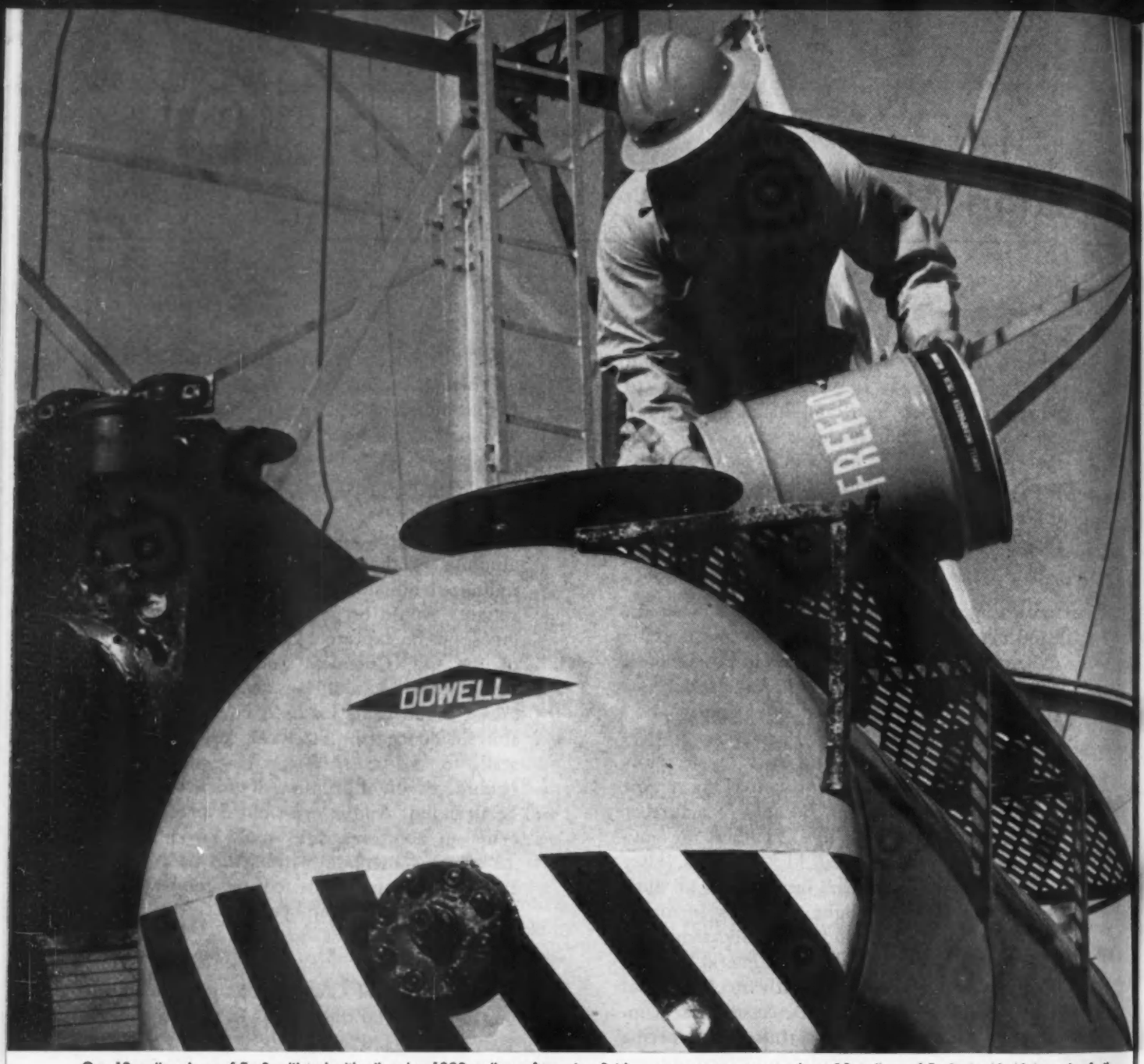
. . . **It will be some time before perfection and commercial use of fuel injection systems to replace carburetors on automobiles.** Experiments with such systems are continuing.

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# Critical Problems Face Oil Men

**An extremely critical year** faces the oil industry of the U. S. Several very important matters are likely to be settled. They are of such far-reaching significance that the industry's operations for years to come are to be vitally affected.

The problems ahead will be of a political or legislative nature, rather than economic. So far as economic prospects are concerned, the industry's outlook is bright. Higher consumption is anticipated, and this will require that increased volume be produced, transported and refined.

Nevertheless, there are several problems which oil men must meet squarely and with resolution in 1956.

•

**Oil imports is one** of the important problems that needs to be settled in some fashion. After years of arguing within the industry as to what should be done about imports and how it should be done, it is probable that some definite course of action will be decided upon during the next 12 months. If oil companies do not achieve some voluntary solution, it is likely that Director of the Office of Defense Mobilization Arthur Fleming will use his powers to impose government restrictions.

The latter would bring another phase of the industry under government regulation. This should be avoided if at all possible. Each additional operation regulated by the government brings the industry closer to complete government control.

Here is a case where warnings by Mobilizer Fleming gives oil companies a choice of doing something themselves or having the government do it for them. The answer will be forthcoming in 1956, and likely will establish a precedent that will have a vital influence for years to come.

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**Whether natural gas prices** received by producers are to be government regulated is another vital problem that will be decided in 1956. Unless the present situation is corrected, the industry will be permanently handicapped and a long, long step will be taken toward national Socialism and death of free enterprise.

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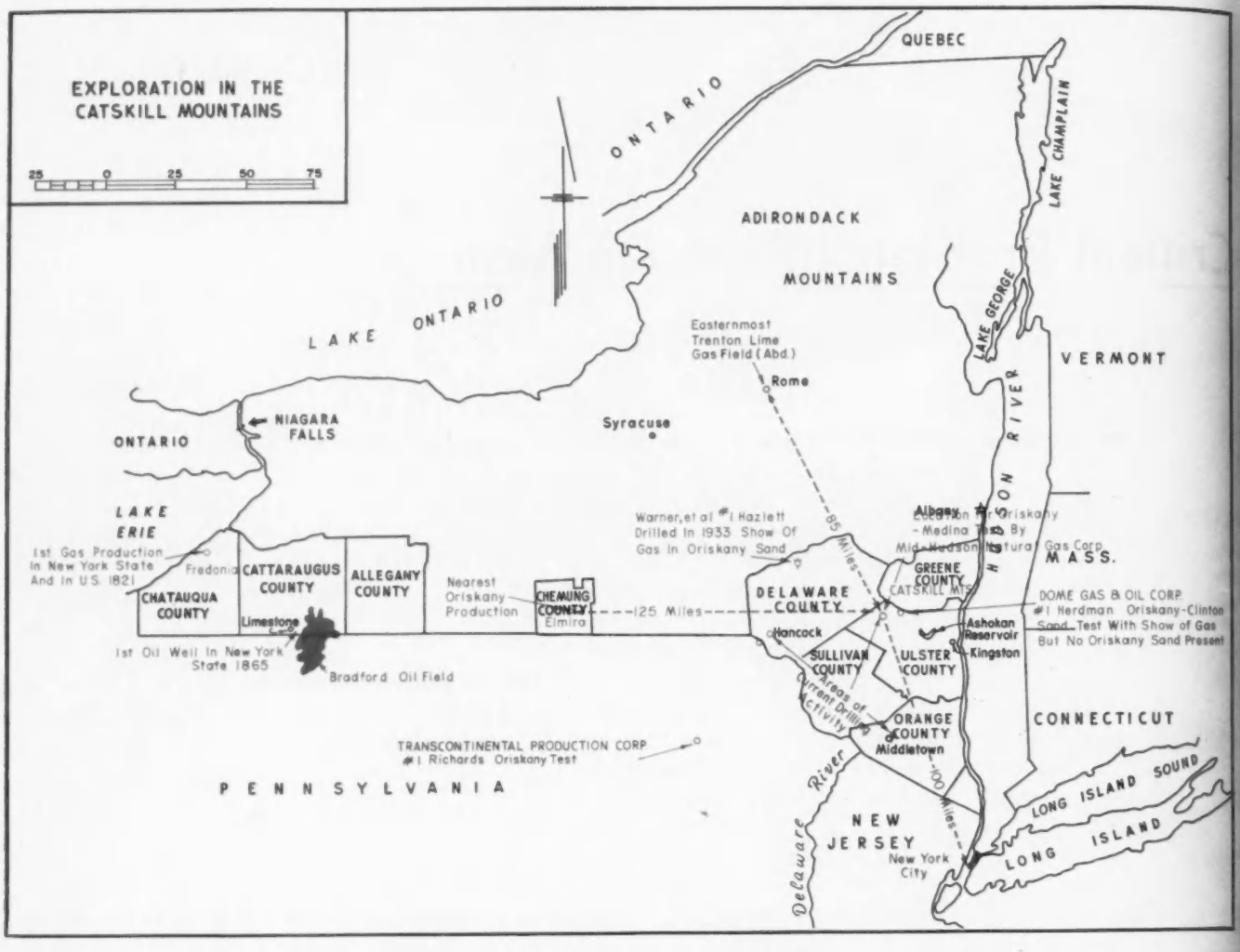
**The depletion allowance** is still another vital long-range matter that may become a problem in 1956. Efforts are likely to be made to reduce the 27½ percent income tax allowance now given the producing branch of the industry.

Nothing could be of greater importance to the industry's future. This long established right must be protected with all the resources of the industry. Every oil man should be anxious to do all that he can to explain this need to the public and members of Congress. Otherwise, the industry may be seriously and permanently injured—and what hurts industry is dangerous to the American people, whether they be laborers or capitalists.

•

**To obtain relief** on these matters through legislative routes is going to take strenuous effort on the part of far more oil men than are now actively engaged in explaining the dangers to members of Congress and the public. Time is short and rapidly running out, yet an entirely too large a segment of the industry is not giving these matters sufficient attention. Much larger scale and more forcible efforts must become engaged in these fights to succeed in correcting some of the most dangerous situations ever to confront the industry. This will require the cooperation of more oil men.

Warren L. Baker




# Natural Gas Production 100 Miles from New York City?

**Catskill Mountains area has gas possibilities. Recent exploratory drilling raises hope for natural gas production 100 miles from New York City.**

**By H. T. BRUNDAGE**
WORLD OIL Staff

CONSIDERABLE INTEREST has been focused on the productive possibilities of the Catskill Mountains area in Greene, Sullivan, Ulster, and Delaware counties in New York state. This area lies about 100 miles north-northwest of New York City.

The most significant drilling has been done by Dome Gas and Oil Corporation of New York City. Their Herdman 1 test in Ulster County near Phoenicia encountered gas in the Devonian shale at 5360 feet. The flow has been gaged at 100,000 cubic feet daily since the formation was penetrated early in 1955. Although no Oriskany sandstone was found, the fact that there has been no decrease in the gas flow is encouraging. The well was drilled to 6400 feet and encountered 185 feet of "Clinton" or Medina sandstone of Silurian age below 6000 feet. No shows were encountered in the lower sand, but it was surprising to find such a large section of this sand. It is not known yet whether this lower sand correlates

**Contractor W. H. Roeder's cable tool rig on location of Dome Gas and Oil Corporation's Ulster County well. The Oriskany and lower Silurian horizons were penetrated with total depth reached at 6400 feet. 5350 feet of 26-pound seven-inch casing was run and cemented to test gas shows.**

with the "Clinton" or with the Medina sand, productive in the western part of the state.

The Herdman well was cased to 5350 feet and the gas horizon was fracture-treated.

Mid-Hudson Natural Gas Corporation of New York City, a close affiliate of Dome Gas and Oil Corporation, has announced plans to drill a second well in the vicinity. The new location will be seven miles west and slightly north of the Herdman test, in Ulster County, one mile from the county line. The same contractor, W. H. Roeder of Bradford, Pa., whose cable tool rig drilled the Herdman well, has moved a standard rig (capable of about 10,000 feet) from Pennsylvania for the operation. Main target will be the Oriskany sandstone. Ten-inch surface string was being run in mid-January at 200 feet. It is hoped that this sand shales out eastward, and that by moving west the operators may encounter favorable Oriskany sandstone on structure.

Transcontinental Gas Pipe Line Corporation of Houston has a contract with Dome Gas and Oil Corporation and its affiliates, whereby Transcontinental has an option to buy natural gas at 27½ cents per thousand cubic feet. If sufficient reserves are developed, Transcontinental will build a pipe line from Phoenicia to New York City. In addition, Transcontinental shares drilling expenses with Dome and its affiliates, and all drilling and geological data are shared among all companies concerned.

If production is found, the area could probably be useful even after depletion as a gas storage field.

The Dome-Mid-Hudson affiliates have more than 37,000 acres under lease in the vicinity, and effectively control a much larger area. Much of Catskill State Park, in particular most of the mountain-top acreage, cannot be used commercially in any way whatsoever, in accordance with the state Constitution, which states that New York's forest preserve shall be "forever wild." Attorney General Nathaniel L. Goldstein ruled in December, 1954, that no drilling for gas and oil could be done within forest preserve land. The ruling is not expected to have any immediate effect on drilling operations in this area. Most of the land in the hollows is private land and since it is much easier to move

**Drilling operations on Dome's Herdman 1, with Mac Roeder, the contractor's son, pulling the bailer. A deep Catskill area test (Ulster County), drilling had reached 5400 feet then. Gas was flowing 50,000 cubic feet per day from Devonian shale, through 8-inch casing. It was ignited for the photographer.**

a rig into a hollow than up a mountainside, most drillsites are in the hollows anyway.

Other companies with leases in Greene, Delaware, and Ulster counties include New York State Natural Gas Corporation, and Basic Refractories Corporation.

Other drilling in the general area includes a test near Middletown, Orange County, New York, 50 miles south of Phoenicia, by Crom Wells Company of Middletown, abandoned at 6438 feet, possibly in the Potsdam formation of Cambrian age, with no shows reported. Also, 50 miles southwest of Phoenicia, near Hancock in Delaware County, an Oriskany test recently has been spudded by a Scranton, Pennsylvania syndicate. The new location is on the New York side of the Delaware River, across from a drillsite in Wayne County, Pennsylvania, where an unsuccessful test has been shut down for some time at about 5000 feet without reaching the Oriskany.

On January 2, Transcontinental Production Corporation of Houston, Texas, spudded an Oriskany test about seven miles west of Scranton, in Lackawanna County, Pennsylvania. A cable tool rig with a 120 foot mast, owned by Acme Drilling Company of Greensburg, Pennsylvania, the contractor, is being used on this, the No. 1 Richards location.

Gas production in New York state dates from 1821 at Fredonia in Chautauqua County. That was the first gas production in the U. S. The first oil production in New York was found in 1865 at Limestone, Cattaraugus County, in what is now the Bradford Field. No production has been found in eastern New York. The nearest previous production to the Catskill area was a Trenton limestone gas field, now abandoned, at Rome, 85 miles northwest of Phoenicia. The nearest Oriskany production of any consequence is at Elmira, 125 miles to the west.

Some shallow gas in water wells near Phoenicia was reported a number of years ago. Considerable geological and geophysical work has been done by various companies in the area immediately west of the Catskills. The geologic structure and stratigraphy are both very complex, and there have been almost no exploratory wells drilled in these counties. Outcrops in the Catskills are plentiful, but the extremely complicated cross-bedding that is so typical of the great Devonian-age Catskill delta makes it very difficult to correlate surface beds and to define surface structures.

In addition, there were three major orogenies during Paleozoic times that affected the older sedimentaries in this area, and resulting structural trends do not coincide. For these reasons, the oil and gas possibilities of the Champlainian trough of eastern New York have been neglected in favor of more easily workable areas. If production is established here, it will be the easternmost production in the U. S., both geographically and geologically, and will undoubtedly focus much attention on similarly long-ignored areas located close to the Appalachian structural front.

—The End

**The voucher system kept on the accrual basis makes possible . . .**

# Streamlined Accounting For the Small Producer

By **HOLIDAY HAYLEY**
Arcadia Refining Company, Tyler, Texas

THE VOUCHER SYSTEM kept on the accrual basis has many advantages to offer a small producer. A certain amount of information is required for tax and management purposes, and the system cannot be simplified as in most other businesses. Accounts should be set up and kept so as to give required information for all tax reports and a monthly financial statement.

Of necessity for tax purposes, the small producer must keep his income and expense accounts by properties. As there are approximately 12 accounts needed, depending upon the classification management uses to reflect profit and loss on each producing property, a small producer with five properties would have about 60 accounts in his Producing Property Profit and Loss section alone. This, of course, requires much individual posting. But the accounting problem for the small oil producer is not too difficult once the system is established along sound accounting principles and workable, convenient accounting forms are used.

Using loose leaf binders and forms, the small producer may keep all accounting records in a minimum of four books with one person keeping his books, or he may have these same records divided into ten or more binders with any number of people keeping them, depending on the size of the business.

**The Voucher.** Heart of the voucher system is the voucher itself. The two kinds used are the cash voucher and journal voucher.

Cash vouchers are carbon copies of checks written. On the reverse side of the voucher is work sheet showing the discount, if any, and accounting to be given the transaction. Attached to the voucher is the statement, invoice and purchase orders supporting the voucher. Vouchers are filed numerically by months. After the transactions are audited, vouchers should be bound together by months and put in the storage file.

The journal voucher is used when the transaction is other than for cash. Papers such as pipe line statements, material transfers, payroll summaries and other forms, should be attached to journal vouchers in support of the accounting.

In connection with the vouchers, a voucher index should be kept. The index consists of small cards listing the name of the payee in the case of cash vouchers and the name of the account in the case of journal vouchers. These cards are filed alphabetically in the index and are used for locating accounts only. Each card shows all voucher numbers over a year's period pertaining to any particular company or person from which the company has made purchases.

Vouchers are numbered numerically by months, and numbers are used to designate the months. The same number is used each month for the journal voucher bringing in the records the payroll voucher. Where number 50 is used, the payroll voucher for the month of March would be 3-50, the number 3 representing the third month in the year.

**The Check Form.** Checks are typewritten and two carbon copies are made, one being the cash voucher and one copy serving as the check stub, furnishing the basis for entries to be made to the cash journal. The check form most commonly used has space for a statement of the account showing dates and numbers of various invoices with the earned cash discount deduction. The statement is detached from the check before cashing.

**Journals and Ledgers.** The books of original entry are the cash book, voucher register and payroll summary. Ledgers needed are the general ledger, accounts receivable, non-producing leaseholds, lease and well equipment, lease revenue and sales with production and maintenance expense combined, general expense, and drilling expense.

**The Cash Book.** Most any regular columnar journals can be used for the cash book, the left-hand page for deposits and right-hand page for disbursements. The disbursement side must have space for both check numbers and voucher numbers. Columns needed other than bank columns are general ledger, accounts receivable, payroll and voucher payable.

**The Voucher Register.** The double-page voucher register has 27 columns showing information to be posted to various subsidiary accounts. A few headings would be date, voucher number, check number and farm revenue, subdivided into lease, barrels and amount credit. Production expense is also divided into three columns, account number, lease and amount debit.

The voucher register reflects various amounts owed by the producer at any time. Check numbers are entered in the voucher register at time checks are mailed to payees. Vouchers appearing in voucher register without check numbers are unpaid vouchers. A mark is made in the check number column opposite journal voucher so they will not be confused with unpaid vouchers.

**Payroll Summary.** As there are numerous deductions made from each payroll check, this is probably one of the most difficult accounting problems the small producer has, together with the accounting he has to do for the various taxes imposed on himself.

Deductions usually made from employes' checks are: house rent, defense

bonds, insurance, FOAB tax and withholding tax. The employer acts as a collection agent for the government for the employes' FOAB taxes and withholding taxes and, at the same time, is liable for his own FOAB tax and an unemployment compensation tax which is payable to both federal and state governments.

It is necessary that these taxes be accrued monthly. Payments are made monthly for employes' and employer's FOAB taxes and withholding taxes by depositing money in a local bank. Banks issue certificates for these deposits which must be submitted with quarterly reports. Quarterly reports and payments are required by the state on unemployment compensation insurance. The federal report on unemployment compensation and the tax are made and paid annually. The payroll summary contains computations of the employer's compensation insurance which is also accrued monthly.

The payroll summary furnishes necessary information for tax reports, compensation insurance reports and an analysis of all charges to be made to various leases, drilling wells and other accounts. All totals and detail are brought onto the books monthly by one journal voucher. Usually the payroll voucher also includes monthly estimate of ad valorem tax expense to make the posting job easier for the bookkeeper.

**Non-Producing Leaseholds Ledger.** This ledger has a sheet for each non-producing lease owned, showing cost, term, acres, name of bank where rental is to be paid and lease form. Total cost of the lease is reflected on this sheet and each rental payment is shown. The non-producing leaseholds ledger is indexed by months. Each lease appears in the book under the month rental is due.

Two methods of accounting are used for non-producing leaseholds:

- Amortization of cost
- Cost charged to expense at time lease forfeited or expired.

When cost is amortized, a portion of the total cost of the leasehold is charged to expense each year according to its term.

When the lease is forfeited by nonpayment of rental, before the end of its term, the remainder of cost is charged to expense in the year forfeited.

When the lease is amortized, it is necessary to have a reserve account on each lease. Space can be provided for this reserve account along with the cost account and rental expense account, thereby having all accounting for non-producing leaseholds on one sheet. This sheet remains a part of the permanent records until the lease meets the expectations of owner and becomes productive or is forfeited by its own terms or by nonpayment of rental.

**About the Author**

HOLIDAY HAYLEY is secretary and treasurer of Arcadia Refining Company, Tyler, Texas, a position which he has held for a number of years. He was born and raised at Bronte, Coke County, Texas. He attended McMurry College, Abilene, Texas, and joined Arcadia shortly after his graduation in 1929. All producing operations of Arcadia are under his supervision.

**Lease and Well Equipment.** The small producer can have good equipment records with very little effort on the part of the staff as the largest part of this permanent record is made when the wells are being drilled and the equipment installed.

Two kinds of forms are used in the lease and well equipment ledger—for (1) lease equipment and (2) well equipment.

The ledger is divided into leases so the total of each lease can be readily obtained. The lease equipment form is a wide double-page form with columns for describing tanks, machinery, serial numbers, and buildings. This page also has ample space for detailed description and columns for showing tubular footage for flow lines, water lines and gas lines.

The well equipment sheet shows total cost of the well, drilling expense, equipment, casing, tubing and rods as to size, amount and quality. The heading of the sheet also shows information concerning the well, usually the location, depth, date commenced, date completed and initial production.

Sufficient space is provided for full explanation of equipment, services and other costs. Voucher numbers are shown and original invoices can be located quickly.

**Combination.** Time can be saved in the bookkeeping job of the small operator if he keeps all profit and loss information for each producing lease or producing royalty on one large columnar sheet. The form used is a large double sheet so arranged with columns to give all needed information.

Beginning on the left hand side are columns for barrels, cubic feet gas, for income from both gas and oil, with a total amount column for both. Then voucher number, date and description columns appear, followed by the expense columns usually numbering about ten accounts. A total expense column is included. Income minus total expense equals gross profit is the next column. The fixed charge columns are next with columns for depreciation, depletion and total. The last column is net profit. Figures are obtained by substracting fixed charges totals from gross profit.

Adjacent to each column on the form is a column headed "Per Barrel." Cost per barrel is calculated monthly and annually and is useful in showing the operator how much he is expending per barrel for labor, taxes and other expenses. Income and net profit likewise are reflected per barrel. Not only does this ledger furnish information as to profit by leases but also information for the monthly gross production tax reports required of the producer by various states.

The small producer will find it convenient to keep the income of his producing royalties along with his leases, providing one part of the ledger for royalties.

**General Expense.** The general expense ledger is a columnar form with a column for each expense account and a grand total column. There are columns for date, voucher number and description. Usually 15 to 20 accounts are required to show general expense.

**Drilling Expense.** The drilling expense ledger reflects well costs by wells. The form for this record was described earlier. On completion of the well, the proper journal voucher is made and the sheet is transferred

*Continued on Page 49*

# CREATIVE BANKING

## *stops the waste of flare gas*

Creative banking builds wealth from waste. Nowhere is this better proved than in a South Texas field where gas was being flared because pressure was too low for gathering lines. No single owner in the field was big enough to put in the necessary packaged gas compressors to boost the pressure. So this project, as another example of creative banking, was initiated and financed by The National Bank of Commerce. As a result, gas that was wasted is now sold at a profit.

Through knowing the producers' specific problems, The National Bank of Commerce was able to provide a solution that made money for everyone. The Oil Loan Department knows that financing must be flexible enough to meet changing conditions as they arise. So many oil men have been helped to build soundly and constructively. Creative banking can help you, too.

***The experience and resources of The National Bank of Commerce of Houston are now being used in Wyoming, Colorado, New Mexico, Texas, Louisiana, and Mississippi.***

**E. O. Buck,** *Vice President, Oil Loan Department.*

**THE NATIONAL BANK OF**

**COMMERCE**

**OF HOUSTON**

***Gulf Building — 712 Main Street***

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

# Atomic Energy Serves Oil Industry

**By ALLAN C. JOHNSON,** Manager, Idaho Operations Office,
U. S. Atomic Energy Commission, Idaho Falls, Idaho

MANY OIL MEN may not know it, but atomic energy has been serving their industry since 1939—six years before the atom bomb became a reality.

The oil industry is today the largest industrial user of radioisotopes. The importance of radioisotopes to the oil industry is emphasized by the fact that one company, located in Houston, Texas, announced that it has put into operation the first laboratory specifically designed to supply radioactive materials to the oil industry.

How is atomic energy serving the oil industry?

**Gamma Ray Exploration.** In the search for new oil fields, techniques evolved from the field of atomic energy are being applied.

One of these involves surface surveys using sensitive radiation detection devices. It has been found that the ground above known oil fields generally shows abnormally low radioactivity compared with non-oil bearing strata, except around the circumference of the oil fields. The sensitive instruments respond to the radioactive material located in the upper six feet of earth. In reconnaissance, the instruments may give continuous readings from moving trucks or helicopters, although in detailed work they are placed at measured sites for stationary readings.

It is believed that the radioactive content of the surface soil normally is leached out by rainfall and by surface water run-off, with the radioactivity normally replaced by a gradual diffusion of ground water from deep in the earth. This deep ground water is believed to contain traces of radium or uranium.

However, when there is a pool of oil underground, it is thought that this pool blocks the diffusion of radium or uranium by ground water, leaving the area above an oil pool abnormally low in radioactivity. Considerable promise is held for this survey technique as a means of reducing the number of dry holes. (WORLD OIL, Aug. 1, 1954, page 107 and Aug. 1, 1955, page 84.)

**Gamma Ray Logging.** In the drilling process, two techniques have been devised to assist in locating possible oil-bearing strata. It has been demonstrated that limestones, shales, etc., show rather high radioactivity, while chalk, salt, sand and water show little radioactivity. Measurement of this intensity is known as gamma ray logging, and has been used for many years. The changes in radioactivity of a formation are watched and compared with other producing wells in the same general area. The hoped-for sequence is a sharp decrease in gamma ray activity between two zones of fairly high activity.

This technique has been improved by introducing a source of neutrons into the hole. The neutrons striking targets such as sand, granite, etc., emit a secondary gamma radiation, which can be recorded by a counter. However, when these neutrons strike materials with many hydrogen atoms, such as oil, shale or water, the neutrons are slowed and absorbed, cutting down the secondary radiation.

Thus a combination of a high primary and a high secondary gamma radiation indicates that the stratum is possibly granite. But within such a stratum one may find a low primary and a low secondary gamma radiation, indicating presence of a porous zone containing oil—or, unfortunately, water. Other combinations indicate different strata, such as salt, limestone or sand. The total effect of gamma ray and neutron well logging is to reduce much of the uncertainty in bringing in an oil well.

These techniques, or adaptations of them, also are of use once an oil well has been drilled. These are the only logging methods that can be used when a well has been cased.

Sometime producing horizons are overlooked in the early stages of drilling. Uses of radiation can determine where the production is, thereby making it possible to recomplete the well.

It is the only tool available where, for one reason or another, the casing has to be set before a complete log can be made of an open hole.

**Helps in Acidizing.** Another application has been found in the acidizing of oil wells. The rate of flow of an oil well depends among other factors on the porosity of the formation through which the oil flows. As oil is pumped to the surface, particles of limestone are deposited in the formation. As oil flow slackens, hydrochloric acid is forced into the well under pressure to dissolve the limestone and re-establish the flow. Formerly used methods of determining the depth at which the acid should be forced out have been expensive, time-consuming and hazardous, since a well might be ruined by acid forced out at the wrong level.

Now, a small quantity of radioactive iodine is added to the acid. By using a geiger counter, the position of the acid in the well can be determined accurately. When the acid is brought to the proper level the pressure is equalized and the acid forced into the right stratum.

**Other Production Uses.** Other applications of radioactive materials are as tracers to evaluate and control water flooding of oil fields for secondary recovery operations; to test oil well casing cement for leaks; to locate precisely the level of an oil or gas pad in salt domes and thus control brine recovery; to tag drilling mud to determine the permeability of the formation through which drilling is pro-

ceeding; and to tag cement to locate its level around a well casing.

**Pipe Line Applications.** Once oil is out of the ground, there remains the problem of transporting it—a problem solved by use of the pipe line. A pipe line is no better than its welds, and a better means of examining welds has been found in the use of radioactive elements such as iridium 192. This source was used recently in rather a heroic job of radiography involving examination of welds of a 620-mile pipe line in Alaska, over rugged terrain and swampy muskeg. The crews used exterior cameras and portable dark rooms. They successfully operated their equipment in extremely adverse conditions.

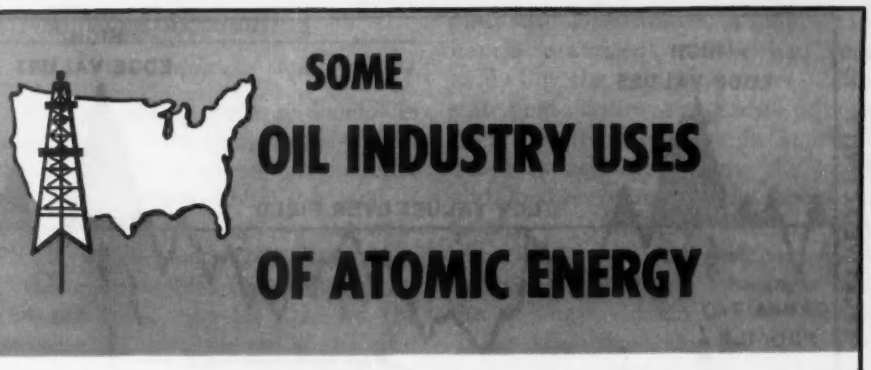
A necessary operation in placing a new line in commission, or in keeping an old line in repair, is go-deviling, moving a swabbing plug through the line. Location of the go-devil when it stuck always has been a problem. A solution is offered in placing a source of radiation, such as cobalt-60, in the go-devil. Its rays can be detected outside the pipe, locating within inches the position of the go-devil when it is stuck. There are problems, such as the need for an extremely intense source when the line is under ground or water, but thousands of dollars already have been saved by this technique.

When pipe lines carry different types of petroleum products, there is the problem of defining the heads of the various columns. In the early days there was much waste by confusion of the interfaces and much was sent to a slop tank for reprocessing.

Now, small quantities of radioactive antimony 124 are injected into the boundary between the various kinds of oil in a pipe. The oil is sent on its way through the pipe line and the arrival of each tagged boundary at a terminal is announced by the clicking of a geiger counter placed outside the pipe. Valves are then turned to send the various grades of oil to their proper tanks.

By a refinement of this process, the entire operation has been made automatic, with little human supervision. It has been estimated that this technique is saving the petroleum industry about $500,000 a year.

**Uses in Refining.** In the catalytic cracking of petroleum one of the important considerations is measuring




## 1. EXPLORATION

Surface Gamma Ray surveys help find oil fields.

Gamma Ray well logs identify formations . . . show presence of oil and water

## 2. DRILLING & PRODUCTION

Marker directs acid to pay formation in acidizing wells.

Radioactive tracers used in water-flooding

## 3. PIPE LINES

Radioactive materials used for:
Examining welds.
Locating stuck go-devils.
Marking batches of oil.
Aiding automatic operations.

## 4. REFINING

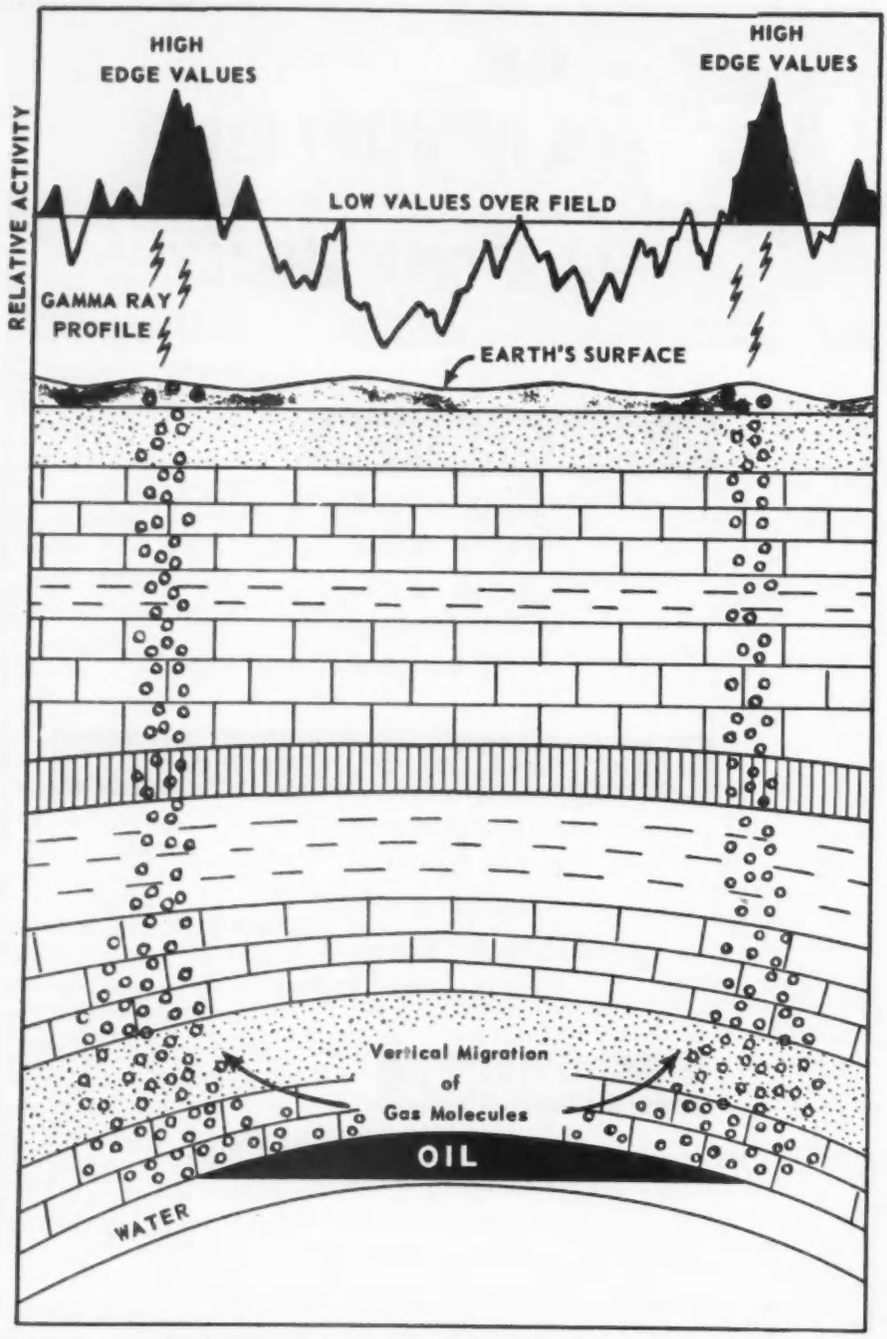
Controlling rate of flow of catalysts.

Studying flow patterns in settling tanks and separators

## 5. RESEARCH

Studying piston wear to improve lubricants.

Promoting chemical reactions.




**Gamma-ray Exploration for New Oil Fields**

**Survey measures radioactivity in top 4 to 6 feet of earth . . . Presence of oil pool blocks natural seepage of radioactivity from the earth except at edges.**

tne rate of flow of the catalyst. A rather dramatic incident occurred in a refinery in Salt Lake City in which the gasoline stock was emerging off-specification, the catalyst was turning black, and could not be rejuvenated. The company faced a possible shutdown with a cost estimated at $100,000. And this at a time when the refinery's gasoline stocks were low.

Scientists tagged the catalyst, which contained zirconium, with radioactive zirconium beads. Using a geiger counter, the rate of flow of the catalyst could be determined accurately, and it was found that this was at fault. A correction was made, the shutdown was averted, and in 24 hours the plant was back to normal. Also, a saving in catalyst was realized on the order of six tons a day, at a cost of about $300 a ton.

Radioactive isotopes are used in determining the uniformity of mixing of liquids or dry solids: For example, in determining the quality of mixing in gasoline blending tanks.

They can be used, also, in measuring various types of concentrations. A researcher at the University of Kansas uses carbon 14-tagged methanol and ethanol in studying multi-component distillation.

Radioisotopes are used in oil refineries and chemical plants in studying flow patterns in settling tanks and separators. In a California Research Corporation study, antimony 124 was injected into the reflux line of a large vacuum tower to determine flow paths in the tower.

Of interest to any phase of the oil industry employing pipes is the use of bromine 82 as a leak detector.

A source of strontium 90 enables researchers to do in five minutes what formerly required two hours in the time-consuming carbon-hydrogen combustion analysis. It has been suggested by Joseph Campbell, former member of the Atomic Energy Commission, that the device permitting this rapid analysis could be applied on stream as a process-control instrument in such operations as catalytic cracking.

Campbell also has suggested that the petroleum industry profitably could utilize a technique improved by scientists at AEC laboratories in Oak Ridge, Tenn., and at Ames, Iowa. This involves a separation device known as counter-current pulsed column for continuous liquid-liquid extraction operations. This column is capable of separating a series of chemical elements known as the rare earths, and Campbell has suggested that its design could be adapted directly to the petroleum industry.

**Aid to Research.** Many are familiar with the use of irradiated piston rings in measuring wear, with the objective of developing better lubricating oils. One West Coast refiner estimates that this technique has done in four man-years and at a budget of $35,000 what by other methods would have required 60 man-years and a budget of about $1 million.

Similarly, compounds are being tagged by radioisotopes in studies to improve the lubricating qualities of oil. High-pressure lubricating greases which contain metallic soaps are being investigated by radioisotope techniques to determine how molecules align themselves between bearing surfaces.

One state highway department is using radioactive calcium 45 to meas-

ure the ability of asphalt to adhere to gravel in a road bed.

It has been suggested by some that a whole new field is opening in the use of radiation as a means of promoting chemical reactions. So important does the Standard Oil Development Company regard this that it has announced plans for a radiation laboratory at its Esso research center at Linden, N. J. The president of the company, Dr. E. V. Murphree, has stated: "Basic research on radiation as a source of energy in bringing about chemical reactions could obviously lead to a host of improvements for the oil and chemical industries and the consumer public."

The company says that its researchers see high promise for the use of atomic energy in the field of polymerization, which is important in the production of synthetic rubbers, lubricating oil additives, blending agents for aviation gasoline, and components of paints, inks and other items.

In this connection it is of interest to know that the Wright Air Development Center at Dayton has developed a vulcanizing process for both natural and synthetic rubber using cobalt 60 as a gamma radiation source.

Indicative of the importance industry is placing on radiation in research is an announcement made recently by the American Machine and Foundry Company. This company has announced plans for building what it expects to be the nation's first nuclear reactor to be owned and operated by private industry. It has sent invitations to join the project to ten companies—among them a representative of the petroleum industry. It is proposed to use the reactor for experimental work.

In summary, a report of Standard Oil of New Jorsey may be quoted. In publishing the results of an eight-year study of possible competitive effects of atomic energy on the petroleum industry, the report concluded: "In the period immediately ahead . . . it is clear that anything atomic energy does to promote industrialization and raise standards of living will create new needs for liquid energy. That, today, is the most significant fact about the relationship between oil and the atom."

ACKNOWLEDGMENT

This article is based on remarks made by the author at the Rocky Mountain District Meeting, American Petroleum Institute, Casper, Wyo.

## Streamlined Accounting

*Continued from Page 44*

from the drilling expense ledger to lease and well equipment ledger. In this way, the producer can readily see, at any time after the well is drilled, the drilling cost on any well. Plenty of columns are provided to separate intangibles from equipment, and the form may be used by the operator whether he drills the well with his own drilling equipment or hires the services of a contractor.

The small producer often is the owner of one or more drilling rigs and drills wells for other operators. The drilling expense ledger can also be used to show the cost and profit from each drilling contract.

**Joint Accounts.** No joint account ledger is required. When the small producer is not the operator, he simply brings on his books monthly the bill from the operator, showing his proportionate part of the expenditures. The joint accounts columns of the voucher register are not used.

When the small producer is the operator, the voucher system really pays off in accounting to his partners. Each joint account is assigned a number. Each month the non-operating owner is billed with itemized statement, copies of invoices attached. The operator attaches a copy of the statement to his own journal voucher which serves as the accounting support for his own distributions and shows the proportionate part charged to the partners.

A statement and journal voucher are likewise prepared for each number representing a joint account until there are no debit or credit balances remaining in the joint account debit and credit columns of the voucher register at the close of the month's business.

**Depletion and Depreciation.** The small producer usually calculates and figures depletion and depreciation once a year. The calculations are usually made by auditors, as figures are very closely related to deductions made on the producer's annual income tax return. Reserves are kept on work papers as to each lease and are readily available should the figures be needed for management or tax purposes. As no subsidiary records are kept on depletion and depreciation reserves, it is highly important that the complete calculations be kept on the work papers.

**Financial Statements.** A monthly financial statement can be had very easily by the small producer. This statement can be as elaborate or condensed as the owner wants. It is not necessary actually to close the profit and loss accounts on the books to obtain the financial statement. A condensed profit and loss statement can show the month's business and the business, including the month shown, for the year to date. The statement contains the net profit figures by leases and royalties. Figures were obtained from the ledger, "Lease Revenue and Sales with Production and Maintenance Expense Combined."

The balance sheet has an extra column headed "Change for Month," the increases given in black figures and the decreases in red. This column proves very useful to management, especially when a large drilling program is underway and it is necessary for the current position to be watched. Should a complete statement be wanted monthly, or for any month, schedules can be attached showing accounts receivable, unpaid vouchers and the profit figures by leases and royalties, showing the detail as to barrels produced, costs per barrel, profit per barrel and any other detail information wanted.

The monthly financial statements are obtained easily by preparing work sheets to be used throughout the entire year, saving the bookkeeper time in making new work sheets each month. The work sheets are nothing more than columnar sheets, one for the balance sheet and one for the profit and loss statement, which have all general ledger accounts listed as they are to appear on the statements.

The bookkeeper takes a trial balance each month by writing the figures in the proper places on the work sheets. The last figure appearing on the work sheet for profit and loss is the net profit figure for year to date. This profit figure must be placed on the work sheet for the balance sheet which is the only figure on the work sheets not actually taken from the books. The profit and loss accounts are not actually closed each month. In bringing on the trial balance on the work sheet each month one column is skipped. By subtracting the previous month's totals from the totals for the year to date, the amounts for the month's business are readily obtained. —**The End**

# How Lone Star Gas Passes Authority Down

**Top executives overburdened with details? Well, here's how a growing company can meet the problem, by revising its organizational structure.**

**By M. L. BIRD**
Lone Star Gas Company, Dallas

THERE IS nothing more important to a company than its future. To assure this future objective planning is necessary.

The lack of adequate planning is usually the result of top executives becoming so occupied with detail matters that they are unable to concentrate upon the future needs of the business. Consequently, they have failed at times to utilize the knowledge of their experienced people. If top executives are to find time for the planning of company objectives and be assured those objectives will be achieved, they must first develop a sound plan of company organization, have fully qualified personnel in all key positions, and provide effective methods of control.

Functional and regional plans of organization present the most adaptable features for the gas distribution business. The functional plan is the type most commonly found in industry. Unquestionably this type of organization is the most practical for smaller companies where operations are less complex. However, at a certain point of expansion, it becomes difficult to maintain effective management control through a single executive or small group of executives.

The regional system is one in which a divisional executive has charge of all company activities within a given geographical area, and is held fully accountable for operations as though this unit were a separate business.

Recently, Lone Star Gas Company found it advisable to revise its organizational structure and decided on a compromise between the functional and regional plans of organization. While finding it impractical to go the whole way toward regional management, it felt that by setting up its organization on a functional basis that a more effective use could be made of the regional principle for decentralizing certain managerial functions and responsibilities.

Lone Star Gas Company, as is the case with most integrated natural gas companies, has three basic functions —the production of gas, the transmission of gas from field to city gate, and the distribution of gas to burner tips within the city.

Its distribution is divided into three major divisions, serving more than 700,000 customers. General Division of Distribution, which is under the writer's supervision, serves more than 375,000 customers in 394 towns in Texas and Oklahoma, embracing an area of approximately 200,000 square miles. This division is divided into five regions and subdivided into 57 districts.

The regions are under the direction of a regional manager aided by a staff organization in the fields of sales and promotion, engineering, and accounting.

The operating district organizations are under the supervision of a District Manager, who reports directly to the Regional Manager. Because of the wide variation in size and geographic influence, the district organizations are classified into three operating groups for the purpose of providing a most economical pattern of organization.

The Class A District is the large operation, serving approximately 12,000 meters or more. Because of its large scope of operation it is more highly departmentalized than the B and C Class Districts, thereby requiring a larger number of supervisors upon whom the District Manager must depend in carrying out the company's objectives.

**About the Author**

M. L. BIRD, Lone Star Gas Company vice president, directs gas service and maintenance operations for some 390 Texas and Oklahoma towns making up the company's General Division of Distribution. He started his career with Lone Star in 1925 and has held important engineering and supervisory assignments with the company. He is a veteran of World War I and during World War II was commander of Group 19, Civil Air Patrol, and auxiliary to the Army Air Force.

The Class B District organization usually serves from 6000 to 12,000 meters. The pattern of this type of organization of course varies somewhat from the A Class District. Due to being more limited in its scope of operations, the pattern of organization is more centralized, making it necessary to assign broader responsibilities to both the supervisory and non-supervisory personnel.

The Class C District is the smallest of the district operations and consequently the pattern of organization differs considerably from that of the other classes of district. This size district handles approximately 1500 accounts, but seldom will exceed a maximum of 3000.

After the design of the new organization plan had been determined, the first step in implementing the plan was to prepare a master chart of the company's organization as a whole, subdividing it only into the major divisions.

The next and perhaps the most important charting is that of the various organizational components. This serves as one of the most essential tools for control as it is planned in a manner to show the composition of each organization component. These charts are designed on a functional

basis and are subdivided into the various departments. Job classifications, with a space for the number of employes in each classification, are grouped under each department according to the pattern of organization which has been approved by general management. In addition to including the complement of personnel of the various classifications, provision is made for the listing of the authorized number of automotive equipment and other mobile equipment, such as trenching machines, back fillers, air compressors, etc.

To facilitate control over the organization aspects of management and to assure that all responsible administrative heads clearly understand their responsibility, the company prepared an Organization Guide and placed it in the hands of this administrative group. A complete Guide, of which only a pertinent portion is issued to any one executive, consists of:

1. A key map of the company organization and its principal subdivisions.
2. An Organization Directory listing such information as executive personnel by location, towns served, number of meters, and other pertinent information on the district organizations and their subdivisions.
3. Functional organization charts on each organization component which general management has approved as to the pattern of organization and complement of personnel and automotive work equipment.
4. Job classification giving the principal duties and responsibilities, and training experience requirements. In the case of supervisory employes, the job classifications include such additional information as the scope authority, accountability, etc.
5. Salary ranges on all non-supervisory employes, and on all supervisory employes below the rank of those to whom an Organization Guide has been issued.

The realignment of the company organization was dictated by its rapid growth in the last decade, and its main objectives were to further delegate authority in order to lighten the load of detail imposed on top management, and to more clearly define job responsibilities.

As an example of the streamlining effects of the reorganization, the following changes in the writer's headquarters staff are cited. This staff had previously been organized into six departments identified as follows: Engineering Department, Industrial and Commercial Department, Merchandise Department, Dealer Assistance Department, Meter Maintenance Department, and Supervisor of Building and Maintenance. All of these departments had been operating independently of each other with each reporting to the divisional vice president.

Under the revised plan, these six departments were consolidated into just two—the General Sales and Promotion Department, and the Distribution Department. The consolidation at one stroke reduced by four the number of department heads reporting to the staff head.

Similar revisions were made on down the line in the regional and the district organizations. Like some key management personnel, due to the rapid growth of the company, Regional Managers were burdened with too many detailed responsibilities and had insufficient authority to accomplish their assignments. Consequently, as previously stated, the regional organizations were divided into three staff sections: Accounting, Distribution, and Sales and Promotion.

Space will not permit the detailing of the many changes that were made in the reorganization but it is well to mention one highly important matter that most gas company executives have to deal with, and that is control over expenditures. In an organization like Lone Star, it is necessary that regional and district managers have some authority to incur expenses in ordinary operations, and to make contributions and donations. It is equally necessary for top management to hold a tight rein on this function. A satisfactory arrangement was accomplished by granting headquarters staff officials authority to spend within certain stated limits. Down the line this authority was delegated in amounts commensurate with the regional and district operations of each locality.

The variations that will be found in the approved district organization components of comparable size, indicate to some degree the flexibility of the basic organization pattern that was developed for the three classes of the district organizations described. Due to the constant changes that are taking place in the business it was considered important that all controls should be designed to allow changes to be made in an organization pattern with reasonable promptness in order to meet the current needs. An attempt has been made to inject a degree of flexibility in the control procedures over organization by broadening the duties in certain of the job classifications and by permitting a degree of variance from the established organization patterns based upon the volume of work.

For example in a small Class B District the typical pattern of organization provides for a storekeeper and/or warehouse clerk, or both, depending upon the work load. Under circumstances where the volume of stores work over a period was found insufficient to require 50 percent or more of one man's time, a storekeeper could then not be justified. Recommendations would therefore be made for the authorization of a warehouse clerk with joint assignments for clerical duties in either the Shop Department or the Commercial Office. In this instance manpower has been kept consistent with the current needs and the expense kept within the proper limits.

Some essential steps have been checked which seem advisable in building the operating structure of a company in order that responsible executives can hold it to its desired character.

As a business expands, the necessity for positive means of communication between top management and line management becomes more urgent. Size has its disadvantages as well as its advantages. To prevent the disadvantages from outweighing the advantages, the organization plan must be continually studied and frequently revised in an expanding company.

The natural gas industry has grown into the stature of big business. In the earlier days, all authority and most administrative functions were concentrated in the head office. But in the complexities of this day, decentralization is the slogan as expanding companies seek an effective pattern of organization that will rescue their top executives from a multiplicity of detail in order that they may turn their energies to the policies and planning which shape the character of their enterprise. **—The End**

# How to Increase Presenteeism

**• Avoidable absenteeism is caused largely by conditions that can be controlled or influenced.**

**• It is the manager's job to discourage absence of workers by finding causes, taking action.**

**By AUREN URIS,**
National Research Institute, New York City

MANAGEMENT PEOPLE *have* burned a lot of midnight oil trying to work out remedies for absenteeism:

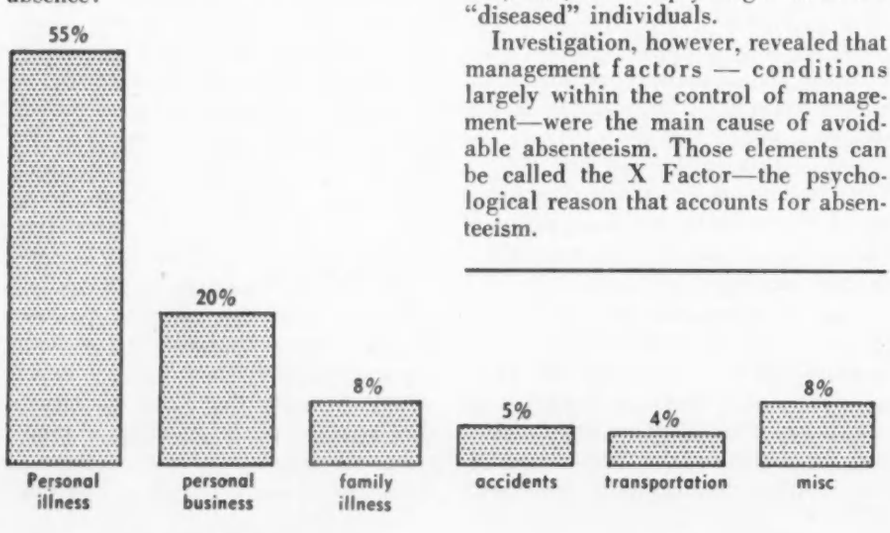
CASH AWARDS. One company developed a system of bonuses to employes for perfect attendance. But it caused trouble: Employes came to work when they *should have* remained home; a worker who *had* to stay out for a perfectly good reason developed a sour outlook on the whole thing.

THE "SHAME-THEM" APPROACH. The company posted the names of absentees on bulletin boards. Results were not satisfactory. Employes resented being held up to public ridicule.

THE SALT MINES. All-time record goes to the Soviet Union. In Russia, absenteeism gets the Siberia treatment.

Even this extreme penalty doesn't put an end to the problem. Absentees still add to the population in the labor camps.

**Reasons and Figures**—Studies of large numbers of absentees over periods of time generally give this kind of picture as to reasons for absence:




Statistics like these are interesting, though not always helpful. The trouble is, these figures often hide as much as they reveal. One man says he "couldn't come to work because of a headache." A week later he refuses to go home despite a temperature of 101—"because I've got an important job to finish." What accounts for contradictions of this kind?

Studies by psychologists show that there is an intangible factor causing absenteeism which frequently eludes the statisticians.

**The X Factor**—Bernard J. Covner in the *Harvard Business Review* relates the about-face in one company's thinking after it really studied its absentee difficulties. Management began by hoping it could find a "convenient means for getting rid of worst offenders, and preventing the hiring of potential offenders."

According to their view, absenteeism was a specific ailment, like shingles or athlete's foot, that afflicted certain individuals. The way to stop absenteeism, then, was simply to get rid of the "diseased" individuals.

Investigation, however, revealed that management factors — conditions largely within the control of management—were the main cause of avoidable absenteeism. Those elements can be called the X Factor—the psychological reason that accounts for absenteeism.

The X Factor is an integral part of the work scene—in your company, in every company. It figures in the conditions under which an employe does his work. And here we don't mean the lighting, or the color of the paint job on the walls. We're talking about the "emotional conditions," the feelings that exist among employees, and between supervisor and worker.

Many management men, as a matter of fact, can actually "feel" the presence of absence of the X Factor in a given department or company. A calm efficiency, an easy friendliness among the personnel shows the X Factor is present, as surely as the clicks of a geiger counter reveal radioactivity.

How do you build attendance encouraging conditions on the job? A recent study of the relationship between attendance and department size, Table A, gives one revealing answer:

**TABLE A**

| Number of Employes Working in Department | Percent of Employes Having 1 or More Absences per Month |
|---|---|
| 1— 9 | 7.9 |
| 10—19 | 14.8 |
| 20—39 | 24.6 |
| 40 or more | 30 2 |

According to these figures, the smaller a work group, the better its attendance. One likely reason is that the X Factor—good inter-personal relations—is more easily achieved in small groups.

The employes in a small unit tend to develop a stronger feeling of friendliness, of belonging to a team. An individual is more important on a five-man team than he'd be on a 20-man team.

**Supervisor-Employe Relations**—Actually, the ordinary day-to-day activity has a profound effect on the emotional atmosphere on the job.

Take the case of Arthur Sweet, getting out of bed on Monday morning. His wife is still asleep—just as tired as he is. The night before they had been at her sister's wedding and they

## How Much Do You Know About Absenteeism?

If your top executives can answer the questions below, especially No. 9, chances are, absenteeism in your company is under control.

**1.** Which day of the week generally shows the highest rate of absence?

**2.** Which the lowest?

**3.** Which rate of absenteeism is considered to be "normal"?

**4.** Is *length* of absence more important than *frequency?*

**5.** Is sex a factor; that is, do you find a higher or lower absentee ratio among women than men?

**6.** What is an "excused" absence?

**7.** Is there a connection between absenteeism, turnover and injury rates?

**8.** Why can't absenteeism generally be handled by simply cracking down?

**9.** *Is management itself responsible for absenteeism?*

***Answers on Page 58***

had danced until two in the morning.

Sweet goes to the mirror to shave. He looks himself in a blood-shot eye, asks: "To go to work or not to go?"

How he answers that question will depend on the balance he strikes between the negative factors and the affirmative.

NEGATIVE: the bad taste in his mouth, the aching bones, the fuzzy head. If these were the only factors, he'd stay home.

But Arthur Sweet this Monday morning is a man with a background of accumulated experiences, all of which are like little weights thrown into the scale on which his decision is being weighed. Each of them may be small; the question is how they will add up.

AFFIRMATIVE: Somewhere in the back of Sweet's head, these items are adding a little weight to the scale of "presenteeism":

When he first came on the job, Mr. Williams, the foreman,

. . . gave him a lot of personal attention;

. . . was always available when Sweet needed a hand.

In the following months, Williams

. . . helped him make friends with the others on the job;

. . . participated in the casual social life of the work group;

. . . showed consideration for his requests, complaints and suggestions.

And so on. To round out the picture, just add all the items you can think of that make a man feel he's doing a job, not merely holding down a job.

Consider the following three steps in analyzing your company picture and tracing your absenteeism to basic causes:

**1. Get the Figures**—Calculating the rate of absenteeism is the obvious starting point. The formula to use is—

$$\text{percent of absenteeism} = \frac{\text{man-days lost}}{\text{man-days scheduled}} \times 100$$

Company A has 100 employes, each scheduled for eight hours, 24 days of the month. Checking monthly attendance records shows that 210 man-days were lost.

The total man-days are 100 (number of people scheduled) multiplied by 24 (number of workdays in the month) or 2400. Filling in the formula the final calculation would be—

$$\text{percent of absenteeism} = \frac{210}{2400} \times 100 = 8.75 \text{ percent}$$

Questions that often come up in figuring this frequency rate are:

. . . Should excused absences be included? Yes. If they're not, you don't get a true picture.

. . . How about absence that's unavoidable because of serious illness, etc.? That should also be included. The U. S. Bureau of Labor defines absenteeism as "the failure of workers to report on the job when they are scheduled to work—that is, when they are actually 'on the payroll.'"

**2. Evaluate the Figures**—In some cases, an absentee rate of 10 percent may be okay. In others, five percent would call for immediate action. Take the three different departments shown in Table 1. Each has the same number of employes, and the same number of man-days scheduled.

Note that although all show the

**TABLE 1**

| A | B | C |
|---|---|---|
| 1 man out 14 days because of serious illness. | 6 man-days lost. Employe out because of asthma attack. | 5 workers out one day each for "personal business." |
| | 1 man-day lost. Employe had to appear in court. | 5 workers out one day each, "headaches," "upset stomaches," etc. |
| | 7 man-days lost. Two working mothers tending to sick children. | 4 employes out one day each. Transportation. |
| 14 man-days | 14 man-days | 14 man-days |

same number of days lost, it's Department C that needs special action.

**3. Spotlight the Bad Actors**—Absenteeism is usually confined to a small percentage of employes. By using the absentee frequency rate, you can spot them.

Here's how it would work on a departmental basis. Here's a typical list:

| Name | Days absent for month of..... |
|---|---|
| Tom | 0 |
| Bill | 0 |
| Harry | 1 |
| John | 5 |

By simply glancing down this list, you can spot the absentee troublemakers. But be sure not to assume that these individuals are staying out wilfully. They have problems that are keeping them out. The question is how to tackle these problems.

**Handling the Absentee**—Once you've drawn a bead on the individuals causing your absenteeism, you're in a position to apply additional remedies. You have to work more closely with them, to solve what's essentially a mutual problem.

It's a good practice to have a returning employe see his supervisor before starting work. Whether the interview lasts for one minute or 30, the first objective is to establish the *reason for the absence.*

If the supervisor is unconcerned, the employe will adopt a "what's-the-difference" attitude. Regardless of the reason for the absence, you want the employe to know he was missed. Then, if he was away for good reason, he'll be pleased to know he's important to the work. If his reasons aren't quite good enough, he'll recognize the implied rebuke.

As one supervisor put it: "By making a point to talk to every returning absentee, I make it clear that I know they've been out. And one employe who used to have a bad attendance record told me the other day, 'You made me run out of excuses.'"

**Attacking the Cause**—(a) The condition. Let's say, for example, a worker says he's been forced to stay away because of bad weather and overloaded local transportation facilities. You may be able to suggest other ways of making the trip. This is especially true of new employes who aren't familiar with the neighborhood.

(b) The work schedule. You may want to consider changing an employe's hours if an outside situation makes it difficult for him to report in with the others.

(c) The job. In cases where a specific on-the-job condition is at the bottom of the absence, you may be able to remove the obstacle either by re-assignment or by modifying the work itself.

(d) The employe's attitude. You may decide on the basis of your investigation that the cause was not so much any one single factor but the employe's attitude. Frequently, for example, in the case of the transportation hardship, pointing out that other employes have similar—and even worse—problems may help to influence him.

Consider action in the extreme cases. The employe who poses a continual attendance problem may finally have to be disciplined. What you finally decide should grow out of the facts of the case. Don't "make examples."

You may simply have to get tough and choose between further efforts to straighten him out and firing him.

In a period of general labor scarcity it's logical to prolong the straightening-out effort. Four days work out of five is better than none. But watch out: one man's poor attendance may infect others with absenteeism.

**The Cost Factor**—It's sometimes cheaper to put up with the absenteeism than to remove the cause. It's not a happy decision—but there may be no choice. Take the case of the company that suffered high absentee rates in bad weather. Lack of near-by parking space meant that employes had to walk five blocks through snow and cold.

Build a parking lot? The costs were simply too high.

In many cases, though, specific moves on your part can and will make a substantial difference.

## Answers to Quiz

**1.** There's more absenteeism on Mondays.

**2.** Payday.

**3.** According to the U. S. Department of Labor: "Nobody knows what 'normal' absenteeism is."

Company A feels it's doing fine if the absenteeism rate doesn't go over 5 percent. Company B's executives start having ulcers if the rate pushes 3 percent.

**4.** Frequency is generally considered a better measure of the problem. One employe, for example, stays out for 20 days because of illness. Another employe stays out ten different times totalling the same 20 days. It's usually easier to adjust to a single absence of long duration.

**5.** Women present more of an absentee problem. For example, in one departmental study, investigators found that 12.5 percent of the men had one or more absences, against 27.3 percent of women.

**6.** "Excused absence" covers the cases where an employe's request for permission to stay out has been okayed by the supervisor. There is no single rule for excused absences. Custom varies from company to company.

**7.** Many companies have found that absenteeism, turnover and injury rates rise and *fall* together.

**8.** Attempts to decrease absenteeism by stern discipline occasionally have proven effective. However, resultant grievances and generally low morale often became as bad as the original absenteeism.

**9.** The answer to this question lies at the very heart of the entire absentee problem. The fact is—

. . . poor management, specifically poor supervision, *does cause* absenteeism;

. . . good management, especially good supervision, *causes presenteeism.*

—The End.

# Field Well as good producer

## SEAMLESS CASING used

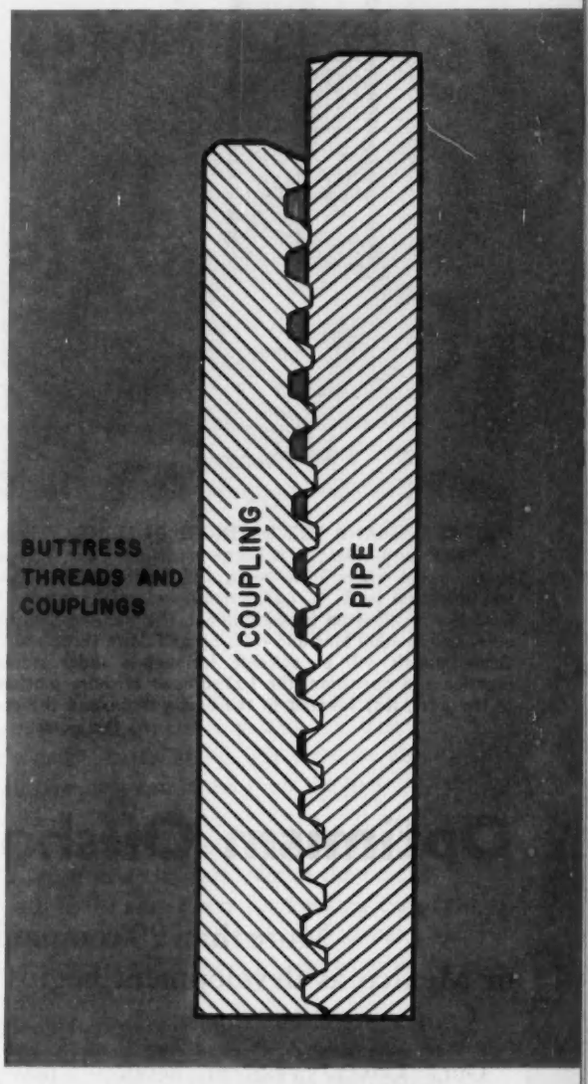
WHEN Southland Royalty Company's Roy Parks, Jr. No. 3, located in the Headlee Field of Midland County, refused to produce, Southland called in The Western Company, of Midland, to fracture the formation. Over a million dollars worth of surface equipment was assembled at the site to gain the desired injection rate in the deep well.

The well had been drilled to the Devonian, and NATIONAL *Deep-Well* and Buttress-Thread Casing had been run and perforated from 11,650 to 11,700 feet. Yet the well had made no commercial show of oil. The fracture treatment made the difference.

First, formation was broken down with crude oil at a pressure of 4800 pounds p.s.i. Then, 10,000 gallons of green oil, containing one pound of sand for each gallon, were pumped into the hole, followed by 290 barrels of flush oil. This stage of the treatment took just 19 minutes at an injection rate of 27.8 barrels per minute. Treating pressures averaged 5800 pounds p.s.i. Following stage one, an additional 38,000 gallons of oil and 18,000 pounds of sand were forced into the formation at a pressure of 6,000 p.s.i. Two days after treatment, the well potentialed 481 barrels of 48 gravity oil through one-fourth inch choke. Tubing pressure was 1700 lbs. and casing pressure was 200 lbs.

NATIONAL Seamless *Deep-Well* and Buttress-Thread Casing was especially developed for just such jobs as this. It possesses the high collapse resistance needed to withstand the tremendous vibrations of deep well drilling, and in this instance the terrific stress of a high pressure frac job. The casing joints are designed to bear the weight of unbelievably long strings of casing. No wonder so many successful oil men inevitably say "NATIONAL SEAMLESS."

For full information on National Tube developments in the oil industry, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.




**The high tensile strength of the Buttress-Thread joint is due largely to the combined effect of the completely engaged runout threads and the three degree flank angle of the thread which support the weight of the casing in the well. The joint is comparable in strength to the body of the pipe. Buttress-Thread casing eliminates the need for upset-end casing—gives greater inside clearance for the drilling bit, and permits easier, faster coupling to power-tight position.**

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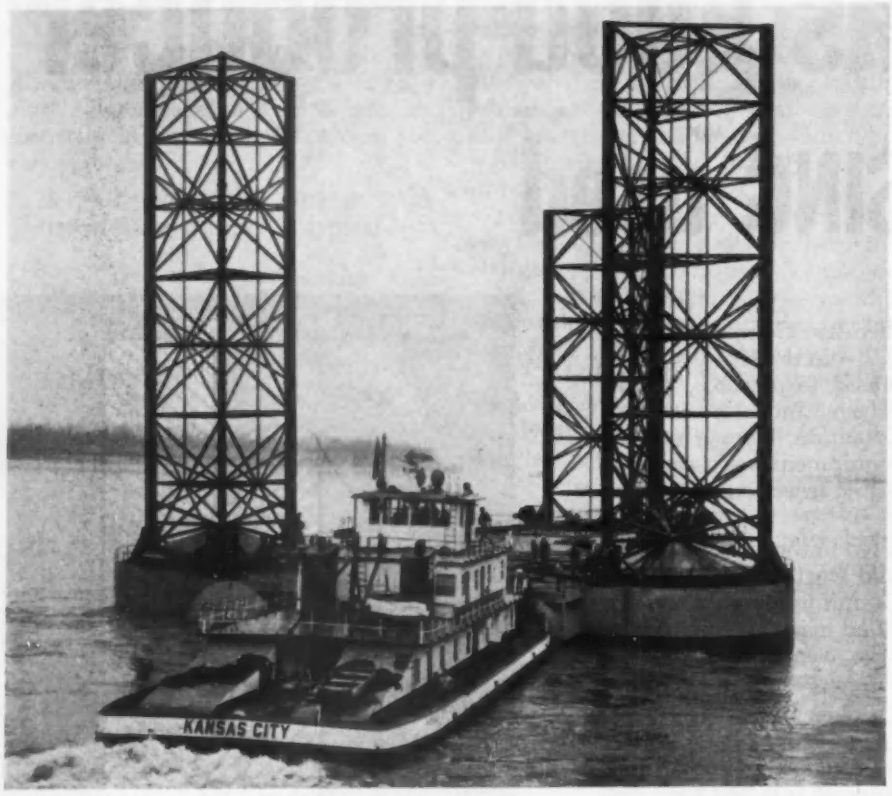



**PORTABLE ISLAND FOR OFFSHORE DRILLING. This portable, self-elevating "island" is shown near Vicksburg, Miss., as it began a trip down the Mississippi. It went through the Gulf of Mexico to Galveston where it is being fitted with drilling equipment for offshore operations. It was manufactured by R. G. LeTourneau, Inc., of Longview, Texas, and bought by Zapata Off-Shore Company of Houston for $2 million. The floating Goliath has a deck area of more than a half-acre, weighs 4000 tons and rides up and down three 140-foot stilts (height of a 10-story building). Other models will be suitable for mobile radar stations, portable docks and other offshore functions. In operation, the LeTourneau offshore platform can be floated from one drilling site to the next, legs lowered to the ocean floor, and the deck self-elevated to desired height above the water.**

# Optimism Offshore

## More than 20 companies now operating in Gulf of Mexico as development begins to justify cost.

GULF COAST OFFSHORE development is beginning to justify the heavy costs that it entails. Operators still use red ink freely in the accounting of their offshore activity. But production of oil and gas is increasing steadily. The operators hope that within a few years, black ink will largely replace the red.

Several companies lately have expressed gratification with their offshore experience. Their comments have appeared in their company magazines and press releases.

The optimism of the operators has been expressed not only in words but also in deeds. Over 20 companies are now participating in Gulf Coast offshore drilling. They are at present drilling 71 wells, the greatest number so far on record. Of these, 64 are located off the Louisiana coast and 7 off the Texas coast. During 1956, the rigs in Louisiana are expected to increase to around 100 and those in Texas to 12.

The Louisiana development is scattered off the coasts of 8 different parishes, between Lake Charles and New Orleans. Especially active is the Mississippi delta country below New Orleans. Texas offshore drilling is off the coasts of Jefferson, Galveston, Nueces, and Kleberg counties, being near Port Arthur, Galveston, and Corpus Christi.

Companies participating in Louisiana offshore drilling include the following: the California Company, subsidiary of Standard of California, drilling 15 wells; Continental Oil Company, operating 7 rigs for the CATC Group, consisting of Continental, Atlantic Refining Company, Tide Water Associated Oil Company, and Cities Service Oil Company; Gulf Oil Corporation, 2 rigs; Humble Oil & Refining Company, drilling 10 wells; Kerr-McGee Oil Industries, 1 rig; Magnolia Petroleum Company, drilling 8 wells for the Magnolia-Continental-Newmont group; Max Pray, one rig; Ocean Drilling and Exploration Company, 1 rig; Phillips Petroleum Company, 2 rigs; Shell Oil Company, 11 operations; Shell and Union Producing Company, 1 rig; Sinclair Oil & Gas Company, 1 rig; Sun Oil Company, 1 rig; The Texas Company, 2 wells drilling; U. S. Oil of Louisiana and Texas, 1 well.

Texas offshore drilling at present includes 3 wells of Standard Oil Company of Texas and one each for Humble, Magnolia, Pure Oil Company, and Stanolind Oil & Gas Company.

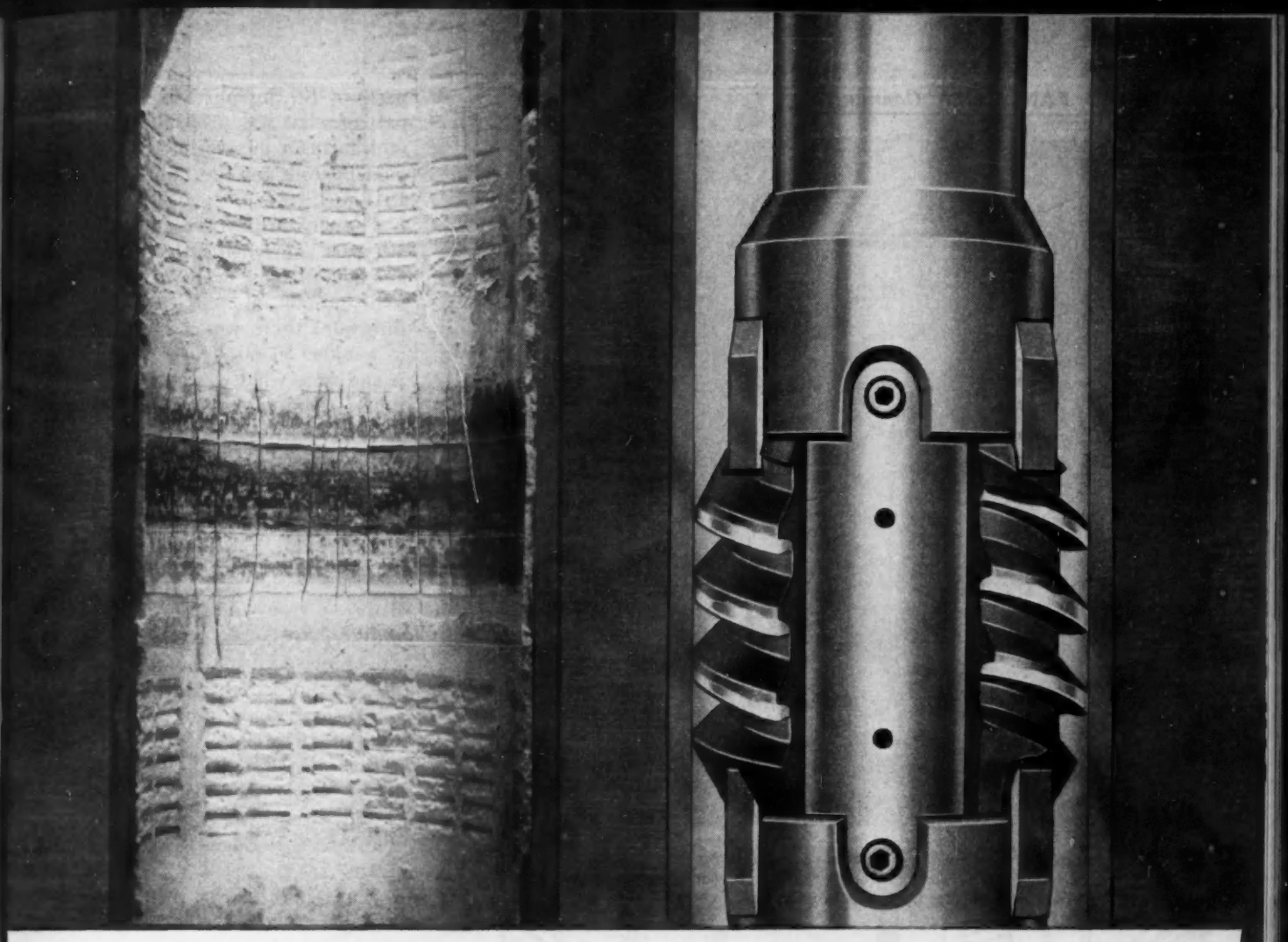
The Louisiana Conservation Commission for January, 1956, allowed crude production of 93,566 barrels per day in some 30 offshore fields. Companies sharing in the allowables included: the California Company, allowed 37,322 barrels daily; Shell, 33,038 barrels; the Magnolia-Continental-Newmont group, 9433 barrels; Humble, 4715 barrels; The Texas Company, 3280 barrels; the CATC group, 2145 barrels; Kerr-McGee, 1574 barrels; Gulf, 904 barrels; Mecom Petroleum, 600 barrels; Ocean Drilling and Exploration, 288 barrels; and Phillips, 267 barrels.

Federal leases off the Louisiana coast only recently became productive.

There is only limited production off the Texas Coast. Discoveries have been made near Galveston and near Corpus Christi.

In the Louisiana offshore areas approximately 65 oil and gas fields have been discovered, although about half of them are shut in for lack of market outlets. In those fields approximately 500 oil wells and 100 gas wells have been completed.

Off the Texas coast, 7 oil and gas fields have been discovered.—**The End**



# CAN YOU AFFORD *Not* to scrape your casing ...*the Baker way?*

*You can't buy insurance for each job—so do the next best thing . . . keep your casing clean with the . . .*

**BAKER**

This is just another way of asking "CAN YOU AFFORD THE EXPENSE OF DOWN-HOLE EQUIPMENT FAILURES?" The unretouched photograph at the above left provides visual proof of how casing neglect can cause even the best pack-off tool to fail.

In this case the pack-off tool set and packed-off perfectly—but the casing ID failed to do its part. Notice the cracks in the cement sheath in the area where the Packing Element was packed-off. *These cracks allowed the fluid under pressure to by-pass, even though the tool was securely set and completely packed-off.*

The Baker Roto-Vert Casing Scraper, which can be run on tubing, drill pipe or wire line, completely removes cement sheath and other obstructions such as perforation burrs and imbedded bullets—prepares the casing ID for subsequent work with pack-off tools. Remember, the condition of your casing ID is just as important to the successful operation of pack-off tools as the condition of a valve seat is to the operation of a valve.

Why take chances with so much at stake? The safe, positive, economical way to eliminate failures, such as the one illustrated above, is to make the running of a Baker Model "C" Roto-Vert Casing Scraper a part of your standard operating procedure.

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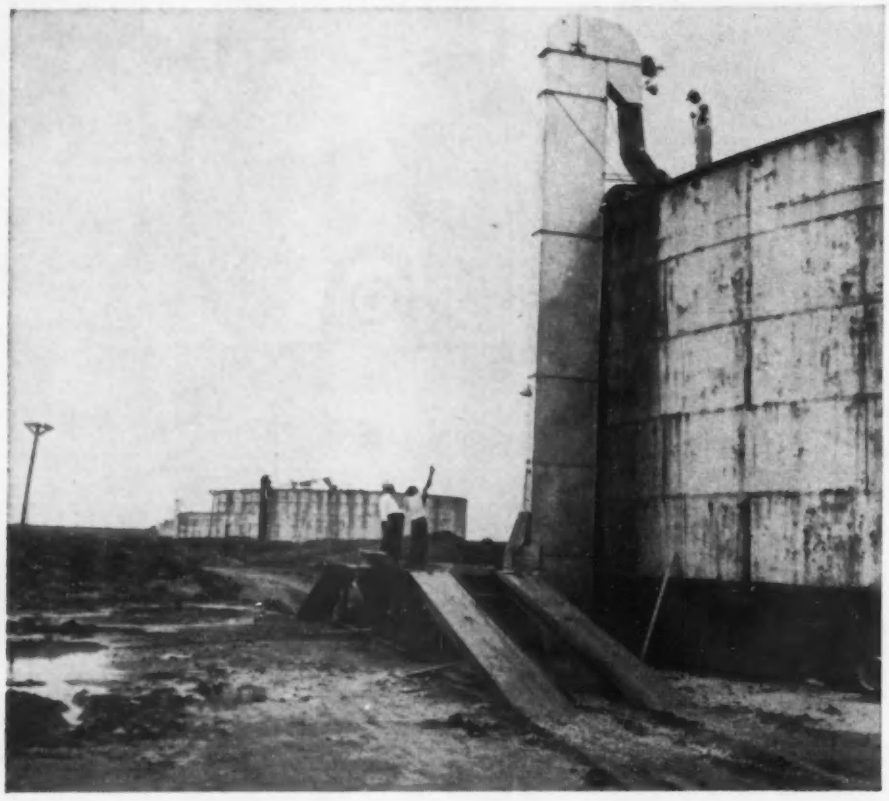

A feed mill company representative points to a special conveyor belt installation on side of tank which will transfer wheat from trucks to storage tank. In the background are tanks that once were part of the Carter Oil Company's Cushing, Oklahoma, tank farm.

# Oil Tanks Help Solve Wheat Storage Problem

**• Oil tanks once used for crude storage in Oklahoma converted into bins for storing wheat.**

**• Conversion may point way for similar use of other idle tanks that cannot be economically moved to new sites for storing oil.**

GIANT 55,000-BARREL capacity crude oil tanks built to conserve a surplus flood of oil in the old Cushing-Drumright field near Yale, Okla., are now being used to store wheat.

This conversion may point the way to a new method for utilizing thousands of barrels of storage capacity in areas where the tanks are no longer needed and where dismantling and hauling to other locations may prove uneconomical.

This application of old lease tanks also is proving most advantageous to the agricultural industry which, with its increasing surpluses, is finding storage a difficult and expensive problem.

Converting crude oil tanks so that they can be "measured in bushels instead of barrels" is an idea developed by The Carter Oil Company.

One Carter veteran who has been with the company nearly 40 years and who visited the scene recalled that the 17 crude oil storage tanks sold to the Dannen Grain and Milling Company of St. Joseph, Mo., once were part of what was probably the largest tank farm in the world. He had handled payrolls for the tank farm from 1918 to 1929.

The tank farm was established some 40 years ago when little thought was given to the oil needs of the future. With prolific oil wells spouting in all directions there was a mad scramble to get the oil out of the ground, sell it and store what was left over. Sometimes, there wasn't enough tankage, and oil deteriorated in open pit storage ponds.

Things have changed since 1915. The Cushing field, which has produced almost 400 million barrels of oil since its discovery in 1912, still produces more than 6000 barrels a day from 1800 wells. However, pumping wells now dot the areas where hundreds of huge storage tanks once held millions of barrels of crude oil.

Purchase of the tank farm property early in 1915 was one of Carter's first ventures in the Mid-Continent area. That same year Western division headquarters were established in Tulsa and J. Edgar Pew was named agent.

Since 1918 Carter has been reducing its tank farm holdings in the Cushing field. It was along about then that the industry learned it was much cheaper, and resulted in the conservation of thousands of barrels of oil, if the oil was kept in the reservoir until it was needed.

In the process of converting the tanks from oil to wheat storage, Carter cleaned, processed the tank bottom residues and recovered some 40,000 barrels of oil and wax products. Then the inside and outside of the tanks were sand blasted and thoroughly cleaned with chemicals to a new brightness. The tanks were then equipped with a special aeration system which keeps the stored grain dry, and they were ready to receive the wheat.

The tanks are being used to store U. S. government-owned wheat that farmers couldn't sell last year. The wheat is being shipped in by railroad from terminal elevators, country elevators and farm storage facilities throughout the Middle West. The converted crude oil storage tanks each have an approximate wheat storage capacity of 4¼ million bushels which can be safely stored for years.

—The End

Illustrated — UNIBOLT Flow Manifold with Plug-Lok and Gauge Valve-Connector. Available in 3000, 5000 and 10,000 lbs. w.p.

# UNIBOLT started something with this FLOW MANIFOLD!

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By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

# Outlook Is Greatly Improved

**FAVORABLE TRENDS** featured the U. S. petroleum industry's economic picture during the past month. Inventories of both motor fuel and distillate fuel oil showed considerable improvement.

Heavy drafts on distillate fuel stocks completely wiped out all prior tendency toward excess quantities. Meanwhile, gasoline stock growth slowed down as comparatively small additions were made to them for this season of the year.

Improved conditions resulted from the combination of weather and satisfactory refining operations. Cold weather brought a sharp boost to the demand for distillate fuel oil. Although crude runs to stills increased, refinery operations were adjusted to manufacture more distillate fuel oil without greatly enlarging the output of motor fuel.

•

**CHIEF IMPROVEMENT** was in gasoline inventories. During the past month they did not accumulate as rapidly as earlier trends had indicated were likely. Additions to stocks during the last few weeks were close to growth a year ago. In contrast, inventory additions in the preceding month were much greater than year ago levels.

Gasoline inventories on January 13, 1956, totaled just under 180 million barrels. This was 9¾ million barrels higher than a year ago. This ratio was only slightly in excess of the relationship that existed in mid-December, when stocks were 8⅔ million barrels greater than in the preceding year.

A rapid increase occurred in gasoline stocks between November 1 and mid-December. This indicated they were going to become excessive before the end of the winter. Although motor fuel inventories were only 2 million larger than a year ago at the beginning of last November, they advanced until they were 8⅔ million barrels greater than the previous year by mid-December. Continuation of this trend would have caused the industry considerable trouble. Consequently, holding of additions to near year ago levels is highly encouraging, and greatly improves the industry's outlook.

•

**IMPROVEMENT ALSO** took place in the distillate fuel oil picture during the past month. Stocks of this product now are in fine condition. Inventories of this product had been reduced by mid-January to practically the same level as a year ago. In contrast, just a month ago they had been 8 million barrels higher than in the previous year. On November 1, they had been 12⅔ million barrels larger than 12 months before.

Stocks of distillate fuel oil totaled 101 million barrels on January 13, 1956. A month ago they amounted to 126 million barrels, and on November 1 they stood at 151¾ million barrels.

This improvement was the result of very heavy consumption because of prolonged cold weather across much of the nation. Large drafts on stocks took place despite increased output by refineries. If cold weather continues, inventories of distillate fuel oil will dip considerably below last year's volumes by the end of the heating season.

•

**THESE DEVELOPMENTS** make the outlook favorable. If the industry continues to adjust refinery operations properly during the next month or two, the gasoline consuming season will be entered with conditions in good shape.

Excessive gasoline stocks can be avoided, something that has caused much trouble in recent years. This calls for continuing present refinery operations, in which emphasis has been placed on the output of distillate fuel oil and output of gasoline has been held to reasonable volumes.

Meanwhile, crude oil stocks also are in good condition. Large refinery runs are offsetting high producing rates, keeping inventories at satisfactory levels.

**BOWEN** *presents a tremendous advancement in Rotary Jar construction*

# SEALED LUBRICATION

**– practically eliminates wear**
**– greatly reduces servicing**
**– assures constant tripping tonnage**

NOTHING PROTECTS METAL SURFACES LIKE AN OIL BATH

The tripping mechanisms in SEALED TYPE "I" BOWEN ROTARY JARS are identical with those in the earlier types of Bowen Rotary Jars that have performed successfully the world over under all types of conditions for many years. These new Jars differ in that they are filled with oil and sealed top and bottom against the ingress of well fluid. With this arrangement, the moving parts of SEALED TYPE "I" BOWEN ROTARY JARS work in a bath of oil and advantages are produced thereby as follows:

**CONSTANT TRIPPING TONNAGE:** The tripping tonnage does not increase or decrease regardless of the presence of sand or oil in the well fluid. The tripping tonnage can be varied only at the will of the operator.

**LUBRICATION:** The oil bath extends the life of the Friction Slip and Friction Mandrel and practically eliminates wear on any other parts.

**INFREQUENT SERVICING:** These Jars can be used to perform several jobs before it is necessary to service them and the servicing procedure is simplified.

The floater is an important part in SEALED TYPE "I" BOWEN ROTARY JARS. It automatically moves up or down the Washpipe maintaining a pressure balance within the Jar and thereby avoids excessive pressures on the Seals.

SEALED TYPE "I" BOWEN ROTARY JARS are installed in fishing strings to enable the operator to strike heavy upward blows against an obstinate fish and knock it loose. They are also installed as safety devices in strings during testing, coring, reaming, drilling, sidetracking and washing-over operations. Their presence insures the operator of the ability to knock the string loose should it stick.

## *Outstanding Advantages*

**SEALED TYPE "I" BOWEN ROTARY JARS** *are straight pull mechanical type rotary jars* **which provide greater efficiency in jarring operations.**

**The ability of these Jars to strike heavy blows with a string completely free from torque eliminates any aggravating tendency to release the fishing tool below the jar. Torque free operation also reduces equipment wear and eliminates hazards.**

**The ability of these mechanical type Bowen Rotary Jars to operate successfully under all conditions has been proven in countless jobs throughout the world for many years. Since these jars are purely mechanical their tripping mechanisms do not depend upon a complicated series of packing elements. Hence their ability to deliver heavy blows is absolutely unimpaired by packing failures, abrasive elements in the circulating fluid or high temperatures.**

**These Jars will deliver the same heavy upward blows regardless of whether the string is elevated slowly or with great rapidity.**

**These Jars feature oversize circulating holes to permit unlimited use of wire line tools and to allow passage of large volume of fluid.**

**After considerable service, the wearing parts of SEALED TYPE "I" BOWEN ROTARY JARS can be replaced easily and economically and the tool will regain all the properties of a new one.**

**SEALED TYPE "I" BOWEN ROTARY JARS**

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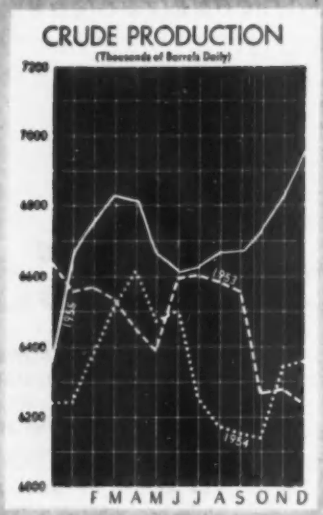
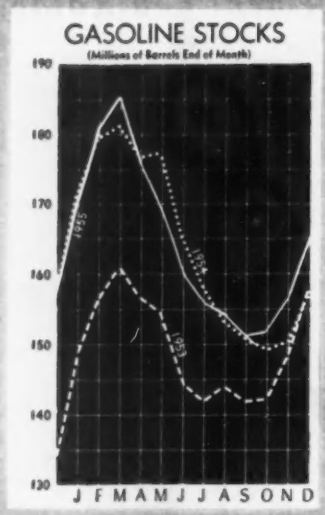
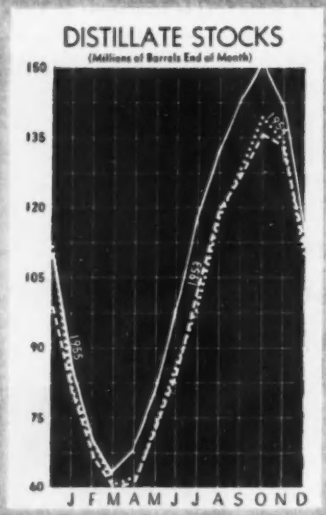
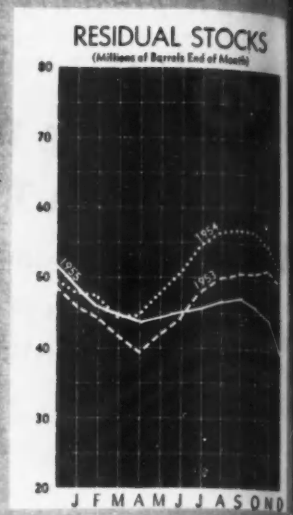
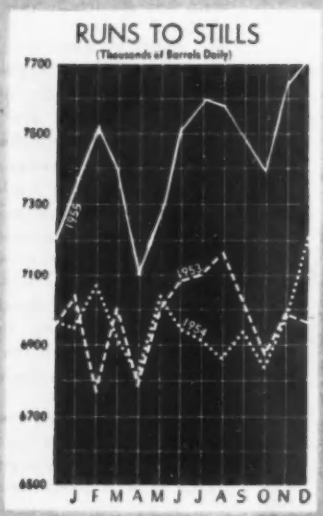
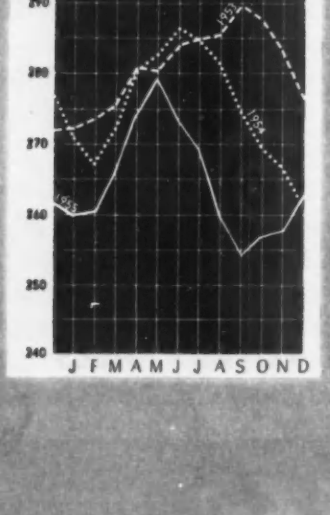



# Petroleum Trends In U. S. . . .

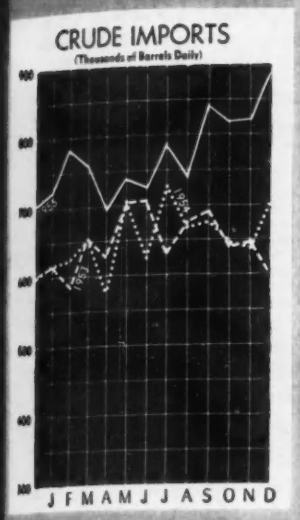
**By CECIL W. SMITH,** World Oil Staff

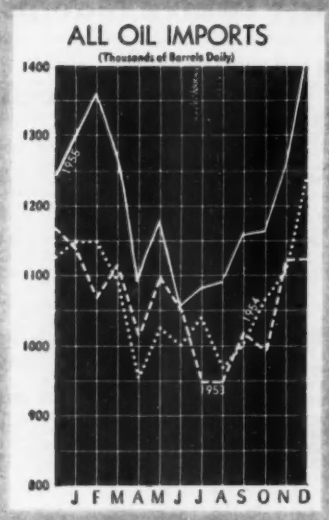
## U. S. Crude Production by States

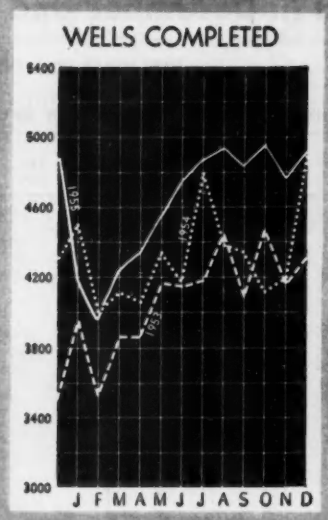
(THOUSANDS OF BARRELS)

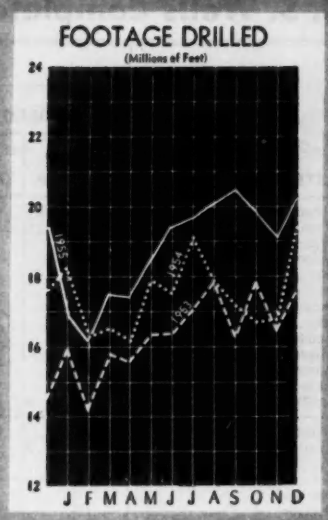
| STATE or DISTRICT | DAILY AVERAGE PRODUCTION Dec., 1955 | Nov., 1955 | Dec., 1954 | % Diff. Dec., '55-'54 | TOTAL PRODUCTION Year 1955 | 1954 | % Diff. '55-'54 |
|---|---|---|---|---|---|---|---|
| Alabama | 4.3 | 4.2 | 4.2 | + 2.4 | 1,378 | 1,584 | — 13.0 |
| Arkansas | 74.2 | 74.2 | 77.2 | — 3.9 | 28,349 | 29,206 | — 2.9 |
| California | 979.1 | 971.8 | 959.5 | + 2.0 | 354,724 | 355,779 | — 0.3 |
| Colorado | 155.9 | 149.8 | 121.3 | + 28.5 | 51,055 | 41,052 | + 24.4 |
| Florida | 1.4 | 1.3 | 1.4 | ..... | 489 | 548 | — 10.7 |
| Illinois | 227.5 | 228.5 | 199.8 | + 13.9 | 81,562 | 66,998 | + 21.7 |
| Indiana | 29.3 | 29.5 | 30.6 | — 4.3 | 10,953 | 11,204 | — 2.3 |
| Kansas | 336.0 | 326.9 | 325.2 | + 3.3 | 121,661 | 119,317 | + 2.0 |
| Kentucky | 40.3 | 42.9 | 39.3 | + 2.5 | 15,113 | 13,791 | + 9.6 |
| Louisiana | 771.8 | 762.8 | 665.7 | + 15.9 | 267,314 | 246,093 | + 8.6 |
| North Louisiana | 116.6 | 116.2 | 114.5 | + 1.8 | 43,368 | 40,997 | + 5.8 |
| South Louisiana | 655.2 | 646.6 | 551.2 | + 18.9 | 223,946 | 205,096 | + 9.2 |
| Michigan | 30.3 | 31.9 | 32.8 | — 7.6 | 11,334 | 12,027 | — 5.8 |
| Mississippi | 112.1 | 110.2 | 93.8 | + 19.5 | 37,317 | 33,591 | + 11.1 |
| Missouri | 0.1 | 0.2 | 0.2 | — 50.0 | 65 | 78 | — 16.7 |
| Montana | 44.4 | 41.5 | 43.4 | + 2.3 | 15,484 | 13,687 | + 13.1 |
| Nebraska | 28.3 | 28.2 | 22.7 | + 24.7 | 9,503 | 7,423 | + 28.0 |
| Nevada | 0.3 | 0.2 | 0.2 | + 50.0 | 66 | 33 | +100.0 |
| New Mexico | 228.6 | 228.3 | 213.3 | + 7.2 | 81,773 | 75,200 | + 8.7 |
| Southeast New Mexico | 227.1 | 226.9 | 2.8 | + 7.9 | 80,837 | 74,408 | + 8.6 |
| Northwest New Mexico | 1.5 | 1.4 | 210.5 | — 46.4 | 941 | 792 | + 18.8 |
| New York | 10.6 | 10.3 | 8.6 | + 23.3 | 3,085 | 3,257 | — 5.3 |
| North Dakota | 35.9 | 33.6 | 25.6 | + 40.2 | 10,971 | 5,979 | + 83.5 |
| Ohio | 12.8 | 12.1 | 10.9 | + 17.4 | 4,322 | 3,829 | + 12.9 |
| Oklahoma | 584.8 | 555.9 | 496.7 | + 17.7 | 201,791 | 186,349 | + 8.3 |
| Pennsylvania | 19.2 | 20.0 | 22.5 | — 14.7 | 8,270 | 9,107 | — 9.2 |
| South Dakota | 0.1 | 0.1 | 0.1 | ..... | 30 | 34 | — 11.8 |
| Tennessee | 0.1 | 0.1 | ..... | ..... | 16 | 17 | — 5.9 |
| Texas | 2,936.7 | 2,882.4 | 2,718.9 | + 8.0 | 1,051,567 | 981,722 | + 7.1 |
| Dist. 1—South Central | 56.4 | 54.2 | 46.3 | + 21.8 | 18,823 | 15,527 | + 21.2 |
| Dist. 2—Middle Gulf | 162.1 | 159.3 | 145.1 | + 11.7 | 55,436 | 52,155 | + 6.3 |
| Dist. 3—Upper Gulf | 439.4 | 433.2 | 438.9 | + 0.1 | 163,799 | 160,003 | + 2.4 |
| Dist. 4—Lower Gulf-S.W. | 246.4 | 244.0 | 239.6 | + 2.8 | 89,034 | 88,617 | + 0.5 |
| Dist. 5—East Central | 49.5 | 48.9 | 43.4 | + 14.1 | 17,740 | 16,133 | + 10.0 |
| Dist. 6—Northeast | 354.8 | 349.1 | 334.7 | + 6.0 | 126,132 | 123,812 | + 1.9 |
| Dist. 7-B—North Central | 150.0 | 149.1 | 129.5 | + 15.8 | 52,384 | 46,561 | + 12.5 |
| Dist. 7-C—West Central | 179.2 | 174.1 | 179.3 | — 0.1 | 66,296 | 65,656 | + 1.0 |
| Dist. 8—West | 992.4 | 965.7 | 869.4 | + 14.1 | 343,776 | 311,196 | + 10.5 |
| Dist. 9—North | 216.3 | 214.6 | 192.5 | + 12.4 | 73,594 | 68,420 | + 7.6 |
| Dist. 10—Panhandle | 90.2 | 90.2 | 84.1 | + 7.3 | 32,328 | 30,299 | + 6.7 |
| Utah | 4.7 | 4.8 | 5.1 | — 7.9 | 2,084 | 1,873 | + 11.3 |
| Virginia | 0.1 | 0.1 | ..... | ..... | 16 | 10 | + 60.0 |
| West Virginia | 6.1 | 6.6 | 7.2 | — 15.2 | 2,332 | 2,902 | — 19.7 |
| Wyoming | 279.7 | 272.2 | 267.7 | + 4.5 | 100,198 | 93,633 | + 7.0 |
| Total United States | 6,954.5 | 6,830.6 | 6,394.0 | + 8.8 | 2,472,827 | 2,316,323 | + 6.8 |

**Source:** Bureau of Mines and API. Texas districts data from API and do not necessarily agree with State totals.



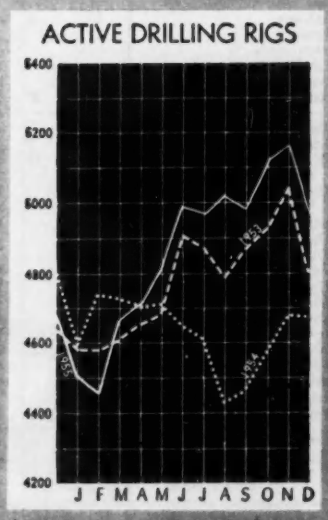

- **Crude production at all-time peak**
- **Refinery activity at highest level**
- **A new high in oil imports reached**

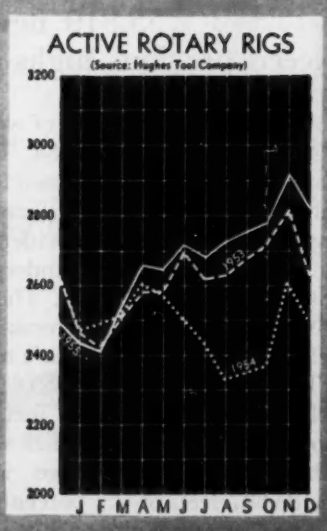
## Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

| MONTH | CRUDE OIL | | | GASOLINE | | DISTILLATE FUEL | | RESIDUAL FUEL | | DAILY IMPORTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production Daily | Runs to Stills Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Production Daily | Stocks End of Month | Crude Oil | Total Oils |
| 1953: | | | | | | | | | | | |
| September | 6,557 | 7,023 | 289,614 | 3,521 | 144,184 | 1,448 | 126,709 | 1,203 | 50,516 | 692 | 1,013 |
| October | 6,262 | 6,872 | 287,541 | 3,437 | 144,495 | 1,462 | 135,409 | 1,184 | 50,820 | 639 | 990 |
| November | 6,277 | 6,987 | 283,021 | 3,528 | 150,747 | 1,463 | 133,381 | 1,223 | 51,267 | 648 | 1,120 |
| December | 6,238 | 6,964 | 276,676 | 3,628 | 159,949 | 1,441 | 111,944 | 1,247 | 49,370 | 598 | 1,121 |
| 1954: | | | | | | | | | | | |
| January | 6,240 | 6,947 | 270,811 | 3,431 | 171,704 | 1,550 | 81,044 | 1,271 | 47,474 | 617 | 1,143 |
| February | 6,379 | 7,068 | 266,918 | 3,476 | 179,950 | 1,545 | 70,390 | 1,241 | 47,119 | 621 | 1,144 |
| March | 6,507 | 6,923 | 271,867 | 3,375 | 181,297 | 1,458 | 60,270 | 1,168 | 44,249 | 654 | 1,088 |
| April | 6,615 | 6,811 | 280,310 | 3,404 | 177,006 | 1,374 | 61,721 | 1,140 | 44,362 | 574 | 950 |
| May | 6,471 | 7,038 | 282,250 | 3,482 | 177,606 | 1,372 | 73,581 | 1,148 | 47,009 | 708 | 1,021 |
| June | 6,500 | 6,947 | 285,155 | 3,483 | 165,404 | 1,399 | 86,325 | 1,123 | 50,216 | 624 | 999 |
| July | 6,242 | 6,916 | 284,894 | 3,480 | 158,010 | 1,416 | 101,657 | 1,089 | 54,365 | 724 | 1,038 |
| August | 6,168 | 6,862 | 281,043 | 3,492 | 153,168 | 1,453 | 117,579 | 1,069 | 56,322 | 664 | 966 |
| September | 6,151 | 6,939 | 274,608 | 3,511 | 150,916 | 1,514 | 128,061 | 1,086 | 56,702 | 672 | 999 |
| October | 6,135 | 6,834 | 269,442 | 3,457 | 149,661 | 1,545 | 139,128 | 1,066 | 56,541 | 642 | 1,065 |
| November | 6,346 | 6,975 | 264,566 | 3,530 | 150,604 | 1,622 | 133,886 | 1,120 | 54,891 | 636 | 1,104 |
| December | 6,394 | 7,238 | 258,385 | 3,605 | 155,400 | 1,668 | 108,144 | 1,187 | 52,105 | 729 | 1,301 |
| 1955: | | | | | | | | | | | |
| January | 6,761 | 7,379 | 260,156 | 3,639 | 169,562 | 1,740 | 86,692 | 1,235 | 49,457 | 739 | 1,348 |
| February | 6,835 | 7,549 | 258,630 | 3,655 | 181,643 | 1,847 | 68,513 | 1,239 | 46,042 | 751 | 1,379 |
| March | 6,886 | 7,374 | 264,430 | 3,543 | 183,972 | 1,703 | 62,457 | 1,185 | 44,970 | 742 | 1,319 |
| April | 6,887 | 7,136 | 275,232 | 3,502 | 175,601 | 1,534 | 70,139 | 1,110 | 43,838 | 697 | 1,123 |
| May | 6,677 | 7,281 | 276,948 | 3,605 | 168,751 | 1,519 | 83,559 | 1,111 | 45,083 | 742 | 1,137 |
| June | 6,613 | 7,484 | 270,850 | 3,725 | 157,439 | 1,628 | 100,652 | 1,080 | 44,398 | 764 | 1,159 |
| July | 6,632 | 7,580 | 264,601 | 3,824 | 157,079 | 1,575 | 119,169 | 1,091 | 44,894 | 860 | 1,161 |
| August | 6,665 | 7,580 | 256,427 | 3,858 | 151,912 | 1,621 | 133,675 | 1,090 | 45,480 | 756 | 1,155 |
| September | 6,731 | 7,483 | 256,269 | 3,784 | 150,194 | 1,621 | 143,248 | 1,061 | 46,267 | 829 | 1,218 |
| October | 6,831 | 7,465 | 267,346 | 3,827 | 153,103 | 1,612 | 152,288 | 1,123 | 47,040 | 821 | 1,206 |
| November | 6,831 | 7,663 | 257,713 | 3,756 | 156,949 | 1,682 | 141,609 | 1,175 | 44,410 | 829 | 1,266 |
| December | 6,955 | 7,669 | 262,033 | 3,856 | 164,859 | 1,772 | 112,791 | 1,343 | 39,872 | 880 | 1,453 |
| Dec., 1955 Change: | | | | | | | | | | | |
| In Month | +124 | +6 | +4,320 | +100 | +7,910 | +90 | −28,818 | +168 | −4,538 | +51 | +187 |
| In Year | +561 | +431 | +4,000 | +251 | +9,459 | +104 | +4,647 | +156 | −12,233 | +151 | +152 |
| Week Ended: | | | | | | | | | | | |
| 1-13-56 | 7,014 | 7,949 | 259,188 | 3,835 | 171,906 | 1,934 | 101,074 | 1,311 | 39,325 | 696 | 1,190 |
| 1-14-55 | 6,689 | 7,370 | 256,519 | 3,541 | 162,198 | 1,718 | 100,111 | 1,248 | 50,566 | 637 | 1,217 |

Source: Data for last two months from API; prior monthly data from Bureau of Mines.



## U. S. Wells Completed in December and First Twelve Months, 1955-1954

| STATE or DISTRICT | NEW WELLS COMPLETED AND FOOTAGE DRILLED — DETAILS FOR DECEMBER: Oil | Dist. | Gas | Dry | Water Input | Gas Input | Water Disposal | TOTAL NEW WELLS: Dec., 1955 | Nov., 1955 | Dec., 1954 | Total Footage Dec., 1955 | DETAILS FOR JANUARY-DECEMBER: NEW WELLS: 1955 | 1954 | Percent Diff. | FOOTAGE: 1955 | 1954 | Rigs in Operation: Dec. 31, 1955 | Nov. 30, 1955 | Dec. 31, 1954 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | | | | 4 | | | | 4 | 4 | 2 | 29,746 | 43 | 69 | — 37.7 | 204,191 | 359,753 | 9 | 8 | 9 |
| Arizona | | | | | | | | | 1 | 1 | | 5 | 10 | — 50.0 | 22,518 | 43,603 | | | 1 |
| Arkansas | 26 | | 1 | 21 | | | | 48 | 86 | 48 | 148,935 | 784 | 581 | + 34.9 | 2,530,207 | 2,049,830 | 45 | 52 | 33 |
| California | 126 | | 3 | 48 | | | | 177 | 204 | 212 | 871,865 | 2,469 | 2,433 | + 1.5 | 12,141,529 | 11,065,195 | 213 | 225 | 245 |
| Colorado | 22 | | 6 | 92 | | | | 120 | 118 | 134 | 718,098 | 1,520 | 1,324 | + 14.8 | 8,208,324 | 7,255,077 | 82 | 96 | 82 |
| Florida | | | | 1 | | | | 1 | 1 | 3 | 4,018 | 26 | 31 | — 16.1 | 179,185 | 195,566 | 3 | 1 | 4 |
| Georgia | | | | | | | | | 1 | | | 2 | 8 | — 75.0 | 9,305 | 20,508 | 2 | 2 | |
| Idaho | | | | | | | | | | | | 3 | 1 | +200.0 | 11,337 | 3,085 | | | 1 |
| Illinois | 192 | | 3 | 209 | | | | 404 | 318 | 338 | 1,026,085 | 3,908 | 3,266 | + 19.7 | 9,449,165 | 7,931,873 | 282 | 311 | 306 |
| Indiana | 20 | | | 32 | | | | 52 | 67 | 77 | 93,074 | 634 | 865 | — 26.7 | 1,006,909 | 1,316,430 | 99 | 101 | 110 |
| Kansas | 191 | | 27 | 195 | | | 1 | 414 | 400 | 421 | 1,512,823 | 4,669 | 4,222 | + 10.6 | 17,605,365 | 15,005,973 | 486 | 490 | 478 |
| Kentucky | 65 | | 16 | 86 | | | | 167 | 176 | 110 | 230,695 | 1,719 | 1,428 | + 20.4 | 2,534,276 | 2,735,151 | 121 | 138 | 92 |
| Louisiana | 190 | 8 | 39 | 132 | | | | 369 | 338 | 328 | 2,272,507 | 4,151 | 3,650 | + 13.7 | 26,890,271 | 22,651,830 | 406 | 398 | 394 |
| North Louisiana | 118 | | 22 | 66 | | | | 206 | 164 | 176 | 678,171 | 2,151 | 1,946 | + 10.5 | 6,829,597 | 5,778,702 | 73 | 78 | 53 |
| South Louisiana | 72 | 8 | 17 | 66 | | | | 163 | 174 | 152 | 1,594,336 | 2,000 | 1,704 | + 17.4 | 20,060,674 | 16,873,128 | 333 | 320 | 339 |
| * Gulf of Mexico | 25 | | 1 | 17 | | | | 43 | 40 | 17 | 383,902 | 360 | 234 | + 53.8 | 3,559,274 | 2,154,631 | 64 | 52 | 33 |
| Maryland | | | | | | | | | | | | 7 | 7 | | 32,127 | 30,753 | | 2 | 3 |
| Michigan | 11 | | 4 | 20 | | | | 35 | 34 | 49 | 106,151 | 512 | 557 | — 8.1 | 1,524,610 | 1,534,855 | 83 | 87 | 96 |
| Mississippi | 15 | | | 23 | | | | 38 | 45 | 55 | 280,640 | 462 | 450 | + 2.7 | 3,370,283 | 3,203,617 | 43 | 35 | 42 |
| Missouri | | | | 1 | | | | 1 | | | 601 | 25 | 11 | +127.3 | 13,696 | 11,798 | 2 | 3 | 4 |
| Montana | 7 | | 1 | 16 | | | | 24 | 47 | 35 | 103,826 | 363 | 349 | + 4.0 | 1,746,638 | 1,406,623 | 45 | 55 | 51 |
| Nebraska | 22 | | | 46 | | | | 68 | 70 | 61 | 375,296 | 847 | 469 | + 80.6 | 4,844,139 | 2,624,696 | 39 | 42 | 34 |
| Nevada | | | | | | | | | | 1 | | 6 | 18 | — 66.7 | 44,828 | 77,166 | 5 | 3 | 6 |
| New Mexico | 62 | | 55 | 21 | | | | 138 | 155 | 102 | 547,118 | 1,726 | 1,168 | + 47.8 | 7,354,782 | 6,133,214 | 167 | 168 | 103 |
| New York | 18 | | 1 | | 11 | | | 30 | 34 | 23 | 43,503 | 367 | 423 | — 13.2 | 510,439 | 782,403 | 48 | 53 | 40 |
| North Dakota | 12 | | | 4 | | | | 16 | 20 | 35 | 121,142 | 253 | 296 | — 14.5 | 1,794,669 | 2,076,265 | 26 | 27 | 25 |
| Ohio | 64 | | 20 | 33 | | | | 117 | 105 | 84 | 263,954 | 1,214 | 1,062 | + 14.3 | 2,547,752 | 2,108,972 | 212 | 215 | 196 |
| Oklahoma | 357 | 4 | 20 | 182 | 8 | | 10 | 581 | 622 | 756 | 2,138,825 | 7,603 | 7,919 | — 4.0 | 26,464,766 | 27,055,491 | 684 | 685 | 679 |
| Oregon | | | | | | | | | | | | 1 | 1 | | 7,101 | 3,684 | | | 1 |
| Pennsylvania | 16 | | 29 | 15 | 10 | 5 | | 75 | 58 | 58 | 215,829 | 1,018 | 1,214 | — 16.2 | 2,831,707 | 3,209,986 | 120 | 122 | 112 |
| South Dakota | | | | | | | | | | 1 | | 12 | 20 | — 40.0 | 52,476 | 102,156 | 2 | 2 | 1 |
| Tennessee | | | | | | | | | | | | | 18 | | | 24,330 | | | |
| Texas | 1,173 | 27 | 62 | 643 | 17 | | | 1,922 | 1,764 | 1,816 | 8,624,307 | 19,953 | 18,539 | + 7.6 | 87,565,959 | 82,279,758 | 1,471 | 1,510 | 1,371 |
| Dist. 1: South Central | 81 | | 3 | 42 | | | | 126 | 162 | 146 | 329,737 | 1,772 | 1,190 | + 48.9 | 4,708,002 | 3,797,362 | 47 | 50 | 48 |
| Dist. 2: Middle Gulf | 25 | 2 | 8 | 28 | | | | 63 | 84 | 63 | 429,802 | 823 | 815 | + 1.0 | 5,022,214 | 4,993,068 | 42 | 41 | 35 |
| Dist. 3: Upper Gulf | 86 | 11 | 2 | 65 | | | | 164 | 131 | 163 | 1,116,228 | 1,789 | 1,760 | + 1.6 | 11,552,991 | 11,698,015 | 136 | 141 | 132 |
| * Gulf of Mexico | | | | | | | | | 1 | | | 14 | | | 138,881 | | 4 | 3 | 3 |
| Dist. 4: Lower Gulf-S.W. | 44 | 12 | 11 | 62 | | | | 129 | 98 | 109 | 718,691 | 1,351 | 1,413 | — 4.4 | 7,192,881 | 7,353,949 | 73 | 83 | 71 |
| * Gulf of Mexico | | | | | | | | | | 1 | | 12 | 4 | +200.0 | 115,549 | 43,131 | 3 | 3 | 1 |
| Dist. 5: East Central | 11 | | 6 | 25 | | | | 42 | 22 | 62 | 174,732 | 281 | 321 | — 12.5 | 1,102,078 | 1,208,106 | 13 | 11 | 19 |
| Dist. 6: Northeast | 25 | | 11 | 35 | | | | 71 | 84 | 103 | 359,728 | 754 | 777 | — 3.0 | 3,997,867 | 4,511,700 | 76 | 71 | 80 |
| Dist. 7-B: North Central | 141 | | 3 | 122 | | | | 266 | 288 | 331 | 891,644 | 3,127 | 3,035 | + 3.0 | 10,184,060 | 9,524,987 | 173 | 168 | 155 |
| Dist. 7-C: West Central | 105 | | 5 | 49 | | | | 159 | 97 | 107 | 775,712 | 1,234 | 1,285 | — 4.0 | 6,524,959 | 6,673,721 | 123 | 135 | 139 |
| Dist. 8: West | 423 | | 2 | 102 | 11 | | | 538 | 362 | 293 | 2,652,935 | 4,106 | 2,892 | + 42.0 | 21,864,008 | 16,997,849 | 438 | 455 | 401 |
| Dist. 9: North | 163 | | 3 | 105 | 6 | | | 277 | 363 | 358 | 847,296 | 3,741 | 4,098 | — 8.7 | 11,954,252 | 12,348,509 | 257 | 255 | 242 |
| Dist. 10: Panhandle | 69 | 2 | 8 | 8 | | | | 87 | 73 | 81 | 327,802 | 975 | 953 | + 2.3 | 3,462,647 | 3,172,492 | 94 | 100 | 79 |
| Utah | | | | 8 | | | | 8 | 6 | 6 | 44,570 | 101 | 69 | + 46.4 | 445,055 | 305,564 | 29 | 33 | 23 |
| Virginia | | | | | | | | | | | | | 22 | | | 105,570 | | | |
| Washington | | | | | | | | | | | | | 8 | | | 20,004 | | | |
| West Virginia | 12 | | 31 | 6 | | | | 49 | 52 | 59 | 122,669 | 639 | 572 | + 11.7 | 1,683,815 | 1,656,347 | 168 | 181 | 199 |
| Wyoming | 12 | | | 28 | | | | 40 | 65 | 59 | 206,747 | 777 | 1,117 | — 30.4 | 3,852,121 | 5,909,032 | 94 | 115 | 76 |
| Total United States | 2,613 | 39 | 318 | 1,866 | 46 | 5 | 11 | 4,898 | 4,791 | 4,874 | 20,103,024 | 55,819 | 52,197 | + 6.9 | 227,479,545 | 211,296,158 | 4,987 | 5,160 | 4,680 |
| Total Western Canada | 149 | | 7 | 66 | | | 2 | 224 | 279 | 302 | 11,458,561 | 2,766 | 2,271 | + 21.8 | 12,141,741 | 8,964,824 | 206 | 228 | 181 |

* Gulf of Mexico wells are included in their respective district totals.

# Records Topple in '55

### 55,819 new wells, 227,479,545 total footage, exceed previous highs of 1954.

A NEW ALL-TIME record of wells and footage was drilled in 1955. The old mark set in 1954, was destined to stand only a year. That a new drilling record was in the making was evident from the start as the industry undertook its task with increased vigor. The result was an increase of 6.9 percent in new wells over the previous year's total.

The final count was 55,819 new wells and 227,479,545 feet. Wells topped 1954's record by 3622 wells, or 6.9 percent, and footage was up 16,183,387 feet, or 7.7 percent.

The year's wells also set a new record in average depths. The national average during 1955 was 4075 feet per well, compared with the previous high of 4048 feet set in 1954. The increase in average well depth accounts for the greater percentage increase in footage than was attained in number of wells.

Of the top five most active drilling states, only one registered a decline for the year. Oklahoma wells dropped to 7603 from the previous year's 7919, a decline of 4.0 percent.

Texas finished out in front with a gain of 7.6 percent. Texas wells amounted to 19,953 against 18,539 in 1954, making it the state's greatest year.

Kansas, the No. 3 drilling state, upped its drilling 10.6 percent to complete 4669 new wells compared with 1954's 4222. In fourth place nationally, Louisiana bettered its 1954 mark by 13.7 percent. There wells totaled 4151 against 3650 a year earlier.

Rounding out the top five states was Illinois with 3908 new wells last year. That represented a gain of 19.7 percent over the 3266 drilled in 1954.

Not included in the first five, but firmly in sixth place was California. On the West Coast, new wells amounted to 2469, a gain of 1.5 percent over previous year's 2433.

Western Canada's operations were boosted 21.8 percent during the year just concluded; completed wells totaled 2766 compared with 1954's 2271.

Contributing heavily to the nation's increased average well depth was South Louisiana, where deep wells are the rule rather than the exception. Average depth of all wells from that area was 10,030 feet in 1955.

*Whether for Outside or Inside Cuts...*

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*Save time—Cut smoother!*

## *Features of Baash-Ross External Cutters*

**SPRING-CUSHIONED** cutting action assures faster, smoother cuts.

**AUTOMATIC SPACING** makes cuts below—not on—couplings or tool joints.

**NO OVERSHOT NEEDED** — cut-off section removed with Cutter. Cut and recover in one trip—with one tool.

**SAME BODY** with simple alterations cuts pipe equipped with any type joint.

## *Features of Baash-Ross Internal Cutters*

**SPRING CONTROLLED** cutting action.

**CENTRALIZED SUPPORT** of Cutter prevents off-center strain on knives.

**REPEATED CUTS** can be made without removal of tool.

**VARIOUS WEIGHTS** of same size pipe can be cut without changing Cutter.

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## Wildcat Drilling—In December and Total Year, 1955-1954

| STATE or DISTRICT | MONTH OF DECEMBER, 1955 | | | | | | TOTAL YEAR, 1955-1954 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New Fields | | | Total Discoveries | Dry Wildcats | Total Wildcat Tests | New Fields | | | Total Discoveries | | Dry Wildcats | | Total Wildcat Tests | |
| | Oil | Distillate | Gas | | | | Oil | Distillate | Gas | 1955 | 1954 | 1955 | 1954 | 1955 | 1954 |
| Alabama | .. | .. | .. | .. | 4 | 4 | .... | .... | .. | .... | .... | 41 | 59 | 41 | 59 |
| Arizona | .. | .. | .. | .. | .... | .... | 1 | .... | .. | 1 | 2 | 4 | 8 | 5 | 10 |
| Arkansas | .. | .. | .. | .. | 11 | 11 | 9 | .... | 2 | 11 | 6 | 140 | 108 | 151 | 114 |
| California | 2 | .. | .. | 2 | 27 | 29 | 18 | .... | 6 | 24 | 10 | 364 | 272 | 388 | 282 |
| Colorado | 3 | .. | 1 | 4 | 58 | 62 | 42 | 1 | 23 | 66 | 74 | 735 | 569 | 801 | 643 |
| Florida | .. | .. | .. | .. | 1 | 1 | .... | .... | .. | .... | 1 | 25 | 28 | 25 | 29 |
| Georgia | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | .... | 2 | 8 | 2 | 8 |
| Idaho | .. | .. | .. | .. | .... | .... | .... | .... | 1 | 1 | .... | 2 | 1 | 3 | 1 |
| Illinois | 7 | .. | .. | 7 | 89 | 96 | 32 | .... | 3 | 35 | 26 | 736 | 594 | 771 | 620 |
| Indiana | .. | .. | .. | .. | 9 | 9 | 9 | .... | 1 | 10 | 11 | 175 | 278 | 185 | 289 |
| Kansas | 11 | .. | 2 | 13 | 116 | 129 | 148 | .... | 35 | 183 | 153 | 1,010 | 765 | 1,193 | 918 |
| Kentucky | .. | .. | .. | .. | 12 | 12 | 13 | .... | 2 | 15 | 20 | 100 | 93 | 115 | 113 |
| Louisiana | 1 | .. | 2 | 3 | 52 | 55 | 40 | 24 | 8 | 72 | 76 | 498 | 394 | 570 | 470 |
| South Louisiana | 1 | .. | 2 | 3 | 27 | 30 | 34 | 21 | 6 | 61 | 62 | 288 | 220 | 349 | 282 |
| North Louisiana | .. | .. | .. | .. | 25 | 25 | 6 | 3 | 2 | 11 | 14 | 210 | 174 | 221 | 188 |
| Michigan | .. | .. | 1 | 1 | 15 | 16 | 5 | .... | 2 | 7 | 12 | 190 | 217 | 197 | 229 |
| Mississippi | .. | .. | .. | .. | 17 | 17 | 7 | 1 | .. | 8 | 6 | 184 | 176 | 192 | 182 |
| Missouri | .. | .. | .. | .. | 1 | 1 | .... | .... | .. | .... | .... | 18 | 11 | 18 | 11 |
| Montana | .. | .. | .. | .. | 11 | 11 | 10 | 2 | 1 | 13 | 12 | 140 | 104 | 153 | 116 |
| Nebraska | .. | .. | .. | .. | 33 | 33 | 38 | .... | 1 | 39 | 34 | 347 | 159 | 386 | 193 |
| Nevada | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | 1 | 4 | 17 | 4 | 18 |
| New Mexico | 6 | .. | 1 | 7 | 7 | 14 | 35 | 2 | 29 | 66 | 62 | 143 | 157 | 209 | 219 |
| New York | .. | .. | 1 | 1 | .... | 1 | .... | .... | 2 | 2 | 2 | .... | 5 | 2 | 7 |
| North Dakota | .. | .. | .. | .. | 3 | 3 | 5 | .... | .. | 5 | 2 | 62 | 110 | 67 | 112 |
| Ohio | .. | .. | .. | .. | .... | .... | .... | .... | 1 | 1 | .... | 15 | 13 | 16 | 13 |
| Oklahoma | 8 | 2 | 3 | 13 | 52 | 65 | 101 | 13 | 22 | 136 | 140 | 641 | 726 | 777 | 866 |
| Oregon | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | .... | 1 | 1 | 1 | 1 |
| Pennsylvania | .. | .. | .. | .. | .... | .... | .... | .... | 1 | 1 | 2 | 2 | 20 | 3 | 22 |
| South Dakota | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | 1 | 12 | 14 | 12 | 15 |
| Tennessee | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | 1 | ..... | 10 | ..... | 11 |
| Texas | 30 | 5 | 9 | 44 | 385 | 429 | 527 | 80 | 74 | 681 | 705 | 4,179 | 4,187 | 4,860 | 4,892 |
| Dist. 1: South Central | 1 | .. | 1 | 2 | 29 | 31 | 23 | 4 | 3 | 30 | 34 | 405 | 321 | 435 | 355 |
| Dist. 2: Middle Gulf | .. | .. | .. | .. | 22 | 22 | 17 | 14 | 13 | 44 | 37 | 269 | 270 | 313 | 307 |
| Dist. 3: Upper Gulf | 1 | 2 | 1 | 4 | 36 | 40 | 17 | 26 | 9 | 52 | 42 | 411 | 410 | 463 | 452 |
| Dist. 4: Lower Gulf-S.W. | 1 | 2 | 3 | 6 | 43 | 49 | 31 | 21 | 11 | 63 | 54 | 407 | 366 | 470 | 420 |
| Dist. 5: East Central | .. | .. | .. | .. | 18 | 18 | 3 | 3 | .. | 6 | 3 | 141 | 155 | 147 | 158 |
| Dist. 6: Northeast | .. | .. | 1 | 1 | 18 | 19 | 4 | 3 | 1 | 8 | 9 | 191 | 177 | 199 | 186 |
| Dist. 7-B: North Central | 6 | .. | 1 | 7 | 83 | 90 | 158 | 1 | 14 | 173 | 201 | 934 | 935 | 1,107 | 1,136 |
| Dist. 7-C: West Central | 10 | .. | 2 | 12 | 41 | 53 | 54 | .... | 11 | 65 | 64 | 291 | 350 | 356 | 414 |
| Dist. 8: West | 8 | .. | .. | 8 | 49 | 57 | 85 | .... | 2 | 87 | 106 | 443 | 368 | 530 | 474 |
| Dist. 9: North | 2 | .. | .. | 2 | 41 | 43 | 131 | 2 | 8 | 141 | 137 | 640 | 777 | 781 | 914 |
| Dist. 10: Panhandle | 1 | 1 | .. | 2 | 5 | 7 | 4 | 6 | 2 | 12 | 18 | 47 | 58 | 59 | 76 |
| Utah | .. | .. | .. | .. | 8 | 8 | 7 | .... | 7 | 14 | 5 | 72 | 45 | 86 | 50 |
| Washington | .. | .. | .. | .. | .... | .... | .... | .... | .. | .... | .... | ..... | 8 | ..... | 8 |
| West Virginia | .. | .. | .. | .. | .... | .... | .... | .... | 8 | 8 | 4 | 13 | 13 | 21 | 17 |
| Wyoming | 1 | .. | .. | 1 | 22 | 23 | 23 | .... | 3 | 26 | 66 | 200 | 217 | 226 | 283 |
| Total United States | 69 | 7 | 20 | 96 | 933 | 1,029 | 1,070 | 123 | 232 | 1,425 | 1,434 | 10,055 | 9,387 | 11,480 | 10,821 |

# Wildcatting at New Peak

### 1954 record topped by 6.1 percent.

LAST YEAR proved to be the most active wildcat drilling year of all time. Six percent more tests were drilled in 1955 than in the previous record-holding year, 1954. This new peak comes as no surprise, because from the outset it was evident that the industry was intent on stepping-up its search for new oil and gas supplies. Whether the campaign lived up to its predecessor's record of uncovering new supplies is not now known. Such an evaluation must come from the computers of newly-found reserves.

However, on a strictly numerical comparison, exploration in 1955 did not quite match the mark set in the previous period. A slightly better success ratio was averaged in 1954 than was experienced last year. In 1954, 1 out of every 7½ wildcat tests drilled proved oil or gas production in some commercial quantity, while 1955 efforts were so rewarded in only 1 of every 8 tries.

A total of 11,840 rank wildcats was completed during 1955, to make it the most active drilling year in history. That record topped the previous high reached in 1954 by 6.1 percent. The year's exploration resulted in the opening of 1425 new producing fields, which lagged behind the previous year's 1434 by 0.6 percent. These 1955 discoveries amounted to 12.4 percent of the total tests drilled, while a year earlier the score had been 13.3 percent of the total.

The year's discoveries were: 1070 new oil fields; 232 new gas producing areas; and 123 gas-distillate fields. Last year marked the third consecutive year that as many as 1000 new oil fields were found.

Oil discoveries in 1955 topped the previous year's by only 14, which figured to be a gain of 1.3 percent. Gas-distillate finds bested 1954's by 4, or 4.2 percent, but natural gas discoveries failed by 28 new fields, or 10.8 percent of matching the previous year's record.

Considerably more money and effort went into last year's wildcat wells than 1954's for they were drilled considerably deeper. The 1955 average depth of all U. S. tests was 4816 feet, while a year earlier they had been carried to 4644 on the average.

**Summary of Results of Wildcat Drilling**

| ITEM | Dec., 1955 | Nov., 1955 | 1955 | 1954 | Percent Dif. |
|---|---|---|---|---|---|
| New Field Discoveries: | | | | | |
| Oil | 69 | 93 | 1070 | 1056 | + 1.3 |
| Distillate | 7 | 8 | 123 | 118 | + 4.2 |
| Gas | 20 | 27 | 232 | 260 | —10.8 |
| Total Discoveries | 96 | 128 | 1425 | 1434 | — 0.6 |
| Dry Wildcats | 933 | 872 | 10055 | 9387 | + 7.1 |
| Total Wildcats | 1029 | 1000 | 11480 | 10821 | + 6.1 |
| Percent Productive | 9.3 | 12.8 | 12.4 | 13.3 | ..... |
| Percent Dry | 90.7 | 87.2 | 87.6 | 86.7 | ..... |

# What the Hugoton Activity Means

- This embayment in southwestern Kansas represents an area where stratigraphic traps provide reservoirs.
- Two of the more important producing formations are the Morrow and the Chester.
- Area has comparatively little structural relief.
- Most promising exploration technique is a combination of intensive sedimentation study coupled with structural framework of time relationship to stratigraphic column.

**By G. F. THOMAS**
Lion Oil Company
Liberal, Kansas

A CONCENTRATED exploration effort by many companies has turned the Hugoton Embayment area of southwestern Kansas from a relatively inactive area exploration-wise to one of the most active areas in the U. S.

Before the discovery of the Liberal-Light pool in 1948, and the Novinger pool in 1950, most of the drilling in the area was limited to the development of the Hugoton field of Permian age with an occasional deep wildcat in other portions of the embayment.

With the discovery of deeper producing horizons and the realization that the area represented a multiple pay prospect, drilling and lease activity increased to a fast pace and has remained in that state with only slight seasonal fluctuations. At present, practically all of the acreage within the embayment proper is under lease with acreage generally considered to be in less favorable localities being rapidly leased by the many companies currently interested in the general area.

Much of the drilling has been restricted to the central portions of the embayment where the Morrow, (oldest Pennsylvanian in the area), and the Chester, (youngest Mississippian in the area), are present. The reason for this is obvious. These two series present stratigraphic trap conditions which are both prolific and widespread. Since these two series show the greatest changes both in thickness and facies changes, and are therefore of the greatest concern to geologists in the area, they are considered at greater length in the discussion than are the other sedimentary units.

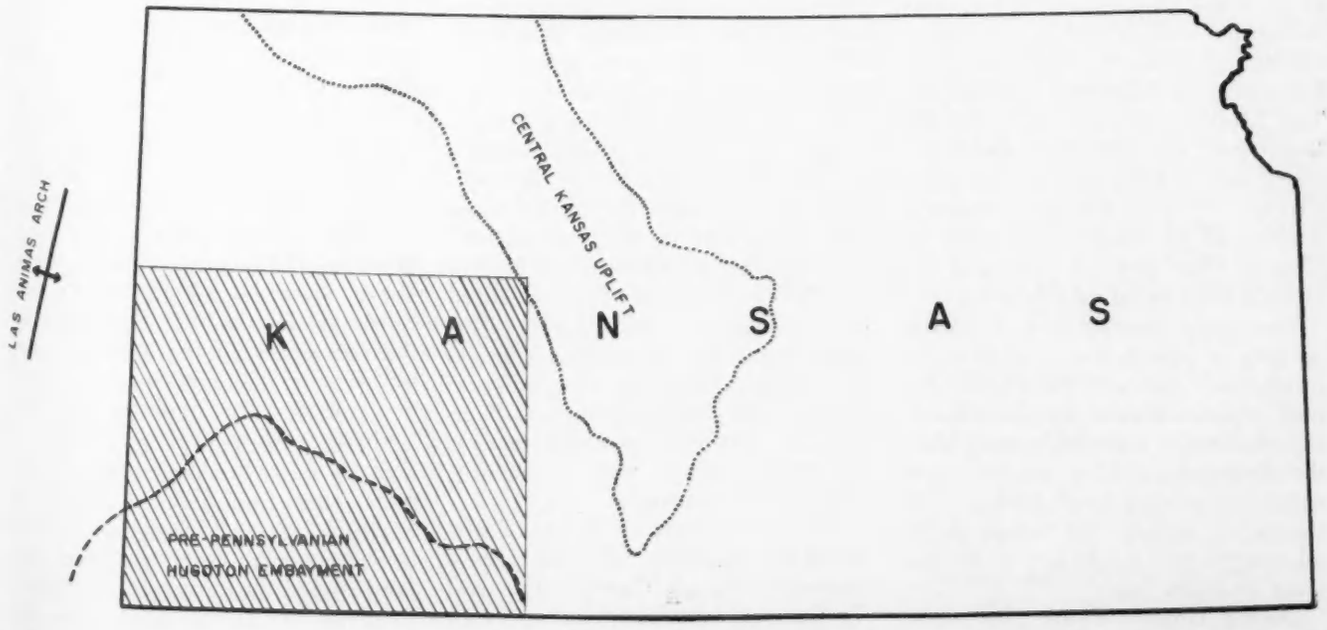



FIGURE 1—Index map of southwest Kansas.

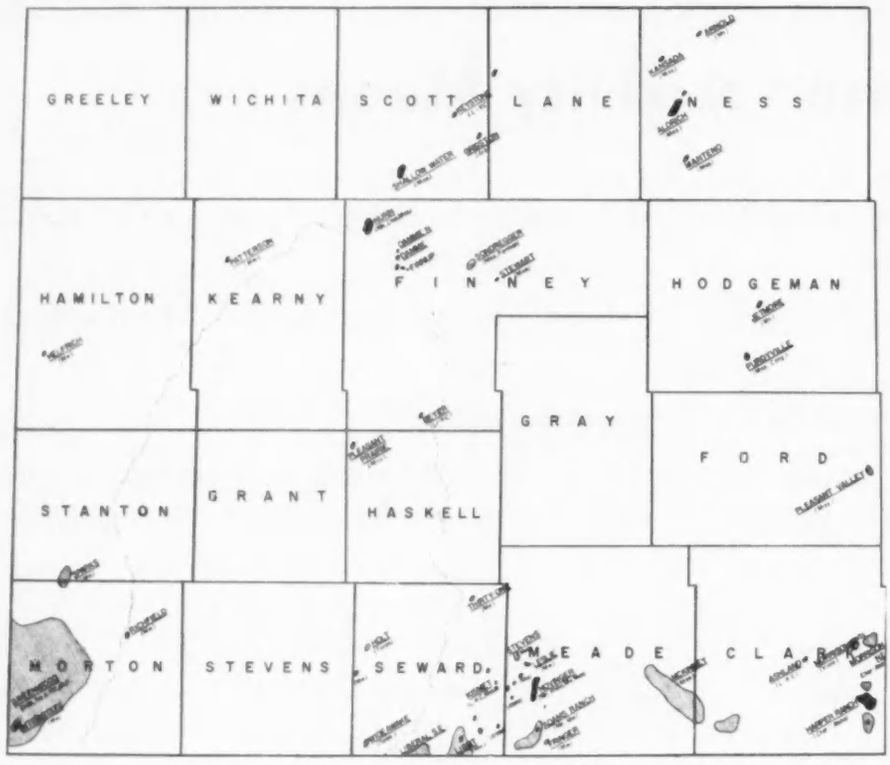



**FIGURE 2—Pool location map of southwest Kansas. Abbreviations: Wab: Wabaunsee; Top: Topeka; L-K-C: Lansing-Kansas City; Mn: Marmaton; Cher: Cherokee; Mw: Morrow; Toron: Toronto.**

**Structure.** The only major structural basin in southwestern Kansas is a portion of the Hugoton Embayment, a northwest extension of the Anadarko Basin. This embayment continues westward into Colorado where it is separated from the Denver-Julesburg Basin by the northeast trending Las Animas Arch. The map showing the Morrow and Chester subcrop patterns defines the general central portions of the old pre-Pennsylvanian and early Pennsylvanian Hugoton Embayment. The Morrow subcrop indicates that Morrowan seas probably covered a larger area than did the previous Chester seas although a certain amount of beveling at the close of Chester time probably reduced the original areal extent of this series.

Essentially, southwestern Kansas is an area of comparatively small structural relief. Although local structures may at times appear to reflect rather tight folding, it is probably more often the illusion created by comparison of somewhat steeper local folding with the gentle regional dip which makes an exaggerated picture on a small scale structure map.

Nosing conditions on most structural maps are the most numerous expression of structure and probably in many cases reflect minor closures superimposed on the relatively uniform regional dip if enough control were available to map in this manner.

In many localities there is evidence of cross-folding due to the non-alignment of forces which acted on the area during the several ages of folding. The older prominent folding with a northwest-southeast alignment was probably most active from the close of Chester time through Morrow time when faulting was forming a general trough area adjacent to and paralleling the northern flank of the Apishapa-Sierra Grande and buried Amarillo mountains trend. Just how far southeast this movement was effective is difficult to trace but it is evidenced by a trough area with a very thick lower Pennsylvanian section composed of a high percentage of clastics in Morton and Stanton Counties, Kansas. This northwest-southeast trending trough area can be seen on the Mississippi structure map.

Younger folding in a northeast-southwest direction apparently continued through Cretaceous and Tertiary time when the northeast trending Las Animas Arch of eastern Colorado was assuming its present form.

Further complications are apparent when the rapid thickening of the lower Pennsylvanian towards the Anadarko Basin is considered with the added factor of subsidence and its effect on regional structure. This causes a general hingeline in the area of the south Kansas state line which was of great importance in the general sedimentation of the area with respect to the position of facies changes in the lower Pennsylvanian.

This change in regional dip becomes more pronounced on the lower Pennsylvanian and Mississippian than on younger formations which indicates that the whole area was a stable shelf during most of later Pennsylvanian time.

**Stratigraphy.** The entire area of southwest Kansas is underlain by rocks of Arbuckle age. To date, the only production from rocks of this age in the area comes from the recently-opened Griggs Pool of south central Scott County. A few wells have penetrated a portion of the Arbuckle in the deeper part of the embayment. The section cut consisted of crystalline dolomites with scattered vugular porosity. None of the wells to date have drilled the entire section.

**Middle and Upper Ordovician.** The Simpson in the area is represented in most cases by slightly less than 100 feet of shaly dolomitic sand and sandy dolomite interbedded with green shales. The lithology in wells which penetrated this section indicates rather poor reservoir characteristics in the general area.

The Viola overlaps the Simpson and varies in thickness from approximately 200 feet along the Kansas-Oklahoma line to a feather edge in northern Greely, Wichita, and Scott Counties, Kansas. Deposition of the Viola continued slightly into southeastern Colorado but was limited by the unwarping in the area after Arbuckle time. The regional cross-section reflects this movement by the thinning of this section westward.

Some flush production from Viola rocks came from the old abandoned Morrison Pool of Clark County and in more recent years from the Ashland Pool of the same county. Neither, however, produced long from the Viola and both went to water rapidly.

In all probability there will be production from the Viola in the area but the economics involved in drilling exploratory wells to this horizon will act as a stalemate for some time to come.

**Mississippi.** Mississippian rocks in southwest Kansas reach a total thickness of over 1000 feet in the central part of the embayment and include rocks of Kinderhook, Osage, Meramec, and Chester ages. The Chester and Meramec wedgeout successively northward in a pattern peripheral to the central portion of the embayment. Movement at the end of Chester time led to the beveling of some prominent local highs which show up on a Chester isopach map.

The Kinderhook has a thickness of from 100 to 150 feet and consists of gray and tan medium crystalline limestones with abundant tan to blue-gray opaque chert.

Immediately overlying this, the Osage series reaches a total thickness of approximately 400 feet. The limestones are gray to brown, finely crystalline, dolomitic in part and separated by dark gray calcareous shales. An abundance of weathered white chert is commonly found near the top of the series.

The Spergen-Warsaw, which overlies the Osage, has a thickness of 350 to 400 feet in the central portion of the embayment. Lithology is generally gray to white or buff, coarse crystalline, fossiliferous limestone with some sucrosic dolomite. Rocks of this age produce gas in the Pleasant Valley Pool of eastern Ford County.

The St. Louis is slightly less than 200 feet in thickness near the Kansas-Oklahoma line in the embayment area. White to gray and tan, coarsely crystalline limestones with oolitic and fossiliferous sections together with tan dense lithographic lithology constitute this formation. Where found, an orange-red vitreous chert is a distinctive feature of the St. Louis. Recent discovery from this formation in southwestern Kansas is the Pleasant Prairie Pool of Haskell County.

The overlying Ste. Genevieve consists of white to gray and buff, finely arenaceous limestones with microoolites in the upper portion. Total thickness reaches 200 feet in the embayment. The high resistivity recorded on an electric log usually identifies the Ste. Genevieve although close sample study is necessary in some areas to distinguish the upper beds of this formation from the lower calcareous sands of the overlying Chester.

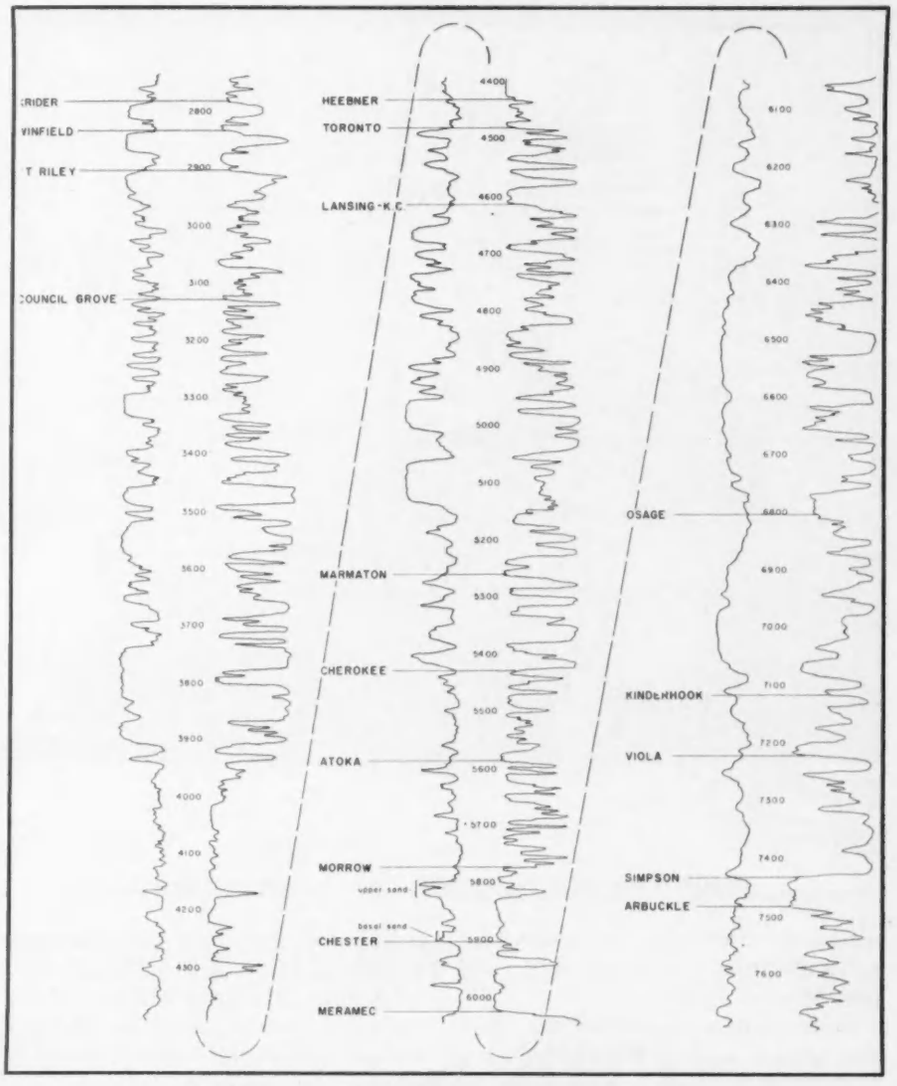



**FIGURE 3—Generalized electric log of southwest Kansas.**

The Chester series, uppermost Mississippian, lies unconformably below rocks of Pennsylvanian age. Thickness varies from 350 feet in the south central part of the Kansas portion of the Hugoton Embayment to a feather edge on the embayment periphery. In addition to this general thinning, beveling over prominent pre-Pennsylvanian highs has taken place within the embayment.

The upper Chester is made up of buff to tan crystalline, oolitic, fossiliferous limestones with interbedded gray and green shales. These upper members are normally porous where not chalky and provide effective stratigraphic trap reservoirs where the overlying Morrow shales seal these truncated sections. The upper Chester Series produces in the McKinney Field of Meade County and in lone producers in Meade and Seward Counties.

The lower Chester is essentially a shale section with thin dense limestone streaks. Near the base a section of variegated maroon and green shales occurs with interbedded very fine grained calcareous sands which are difficult to distinguish from the underlying arenaceous limestones of the Ste. Genevieve. Shows of oil have been encountered in these sands in some wells but low permeability has made recovery impossible.

### Pennsylvanian

• **Morrow**—The Morrow, lowermost Pennsylvanian in the area, exhibits more changes in thickness than any of the overlying Pennsylvanian beds. The greatest area of thickening takes place in the trough area of Morton and Stanton Counties as indicated by the regional cross-section. Thin-

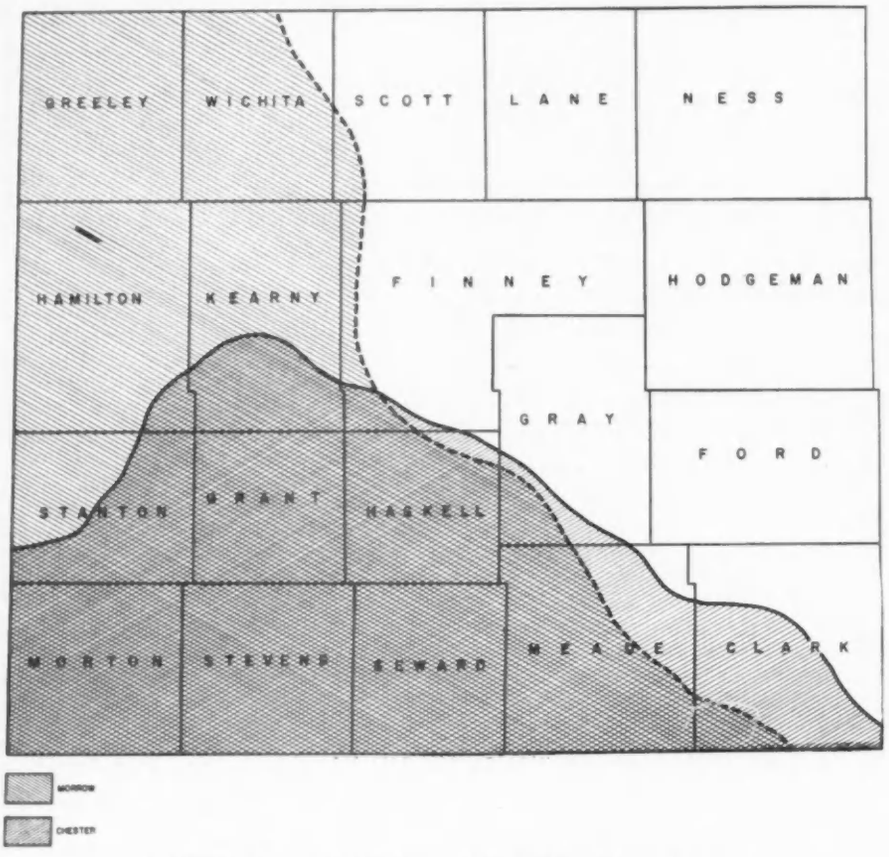



FIGURE 4—Extent of the Morrow & Chester in southwest Kansas.

ning to the north and east results from a combination of marine onlap and post Morrow erosion.

Coal seams at the top of the Morrow section would seem to indicate a rather stable time at the close of Morrow time with widespread lagoonal conditions. Composition of the series is largely dark gray calcareous fissile shales with intercalated impure glauconitic limestones and lenticular sandstones of a local nature.

Lateral variation is rapid and rather unpredictable, particularly with reference to the upper sands. The upper sands, being one of the prime producing targets for exploratory efforts, have precipitated a great deal of study and contemplation by those persons concerned with the area.

The problem is understandably difficult when it is considered that the Morrow probably represents many varied depositional environments. Overall thickness apparently has little relationship to the development of the sands and present structure likewise seems to be coincidental in many cases.

The only workable solution appears to be a meticulate study of the depositional environment of not only the series as a whole, but also individual units which are significant in reflecting the total orderly sedimentation pattern.

In general there are two stratigraphic intervals within the Morrow section which the sands commonly occupy: the lower or basal interval and the upper interval which is usually in the upper one-third of the shale section. The upper sand has provided the best production to date with production from the lower sand being rather disappointing. The former produces in the Light pool, Leslie pool and several lone producers while the latter produces in the Liberal Southeast pool.

• **Atoka**—A series of alternating thin limestones and shales make up the Atoka in the southwest Kansas area. In eastern Clark County, in what has sometimes been referred to as the Clark County Embayment, local sands replace some of the limestones and provide the producing horizons for the Harper Ranch Pool. The cross-section of this pool illustrates the lateral variations of the Pennsylvanian sands and the upper Mississippian.

There is a marked similarity between the Atoka limestones and the overlying Cherokee indicating possible uninterrupted deposition from Atoka to Cherokee time with uniform conditions of deposition.

• **Cherokee**—Cherokee rocks are present over the entire area and consist of dark gray to black chunky carbonaceous shales with tan to dark brown cherty limestones. The limestones are mostly dense with poor reservoir characteristics.

• **Marmaton**—The Marmaton group has a fairly constant thickness over southwest Kansas and is composed of chalky to porous fossiliferous limestones with thin interbedded shales. The Novinger Pool of Meade County produces from a lenticular body of bioclastic material within the Marmaton. Individual limestones within the group exhibit rapid lateral changes in thickness and porosity indicating that, in all probability, additional pools of a character similar to the Novinger will be found. Gas shows have been reported from the Marmaton in several wildcats drilled in this area.

• **Lansing-Kansas City**—Gray to

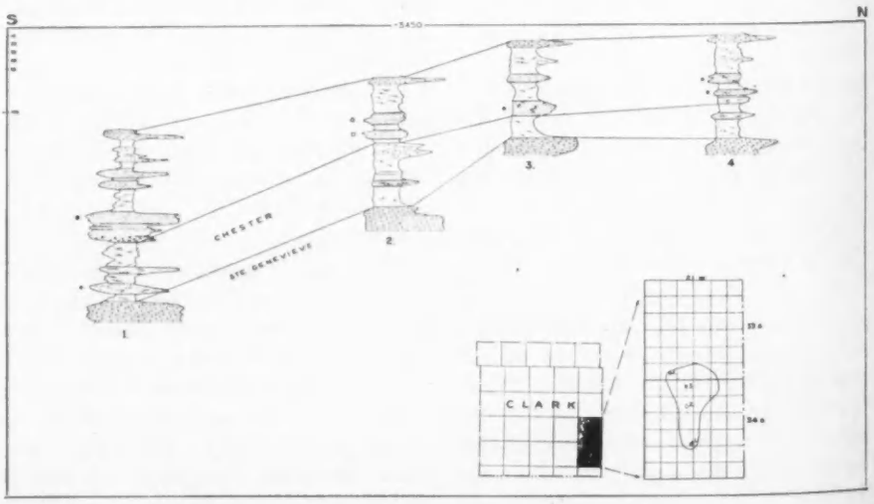
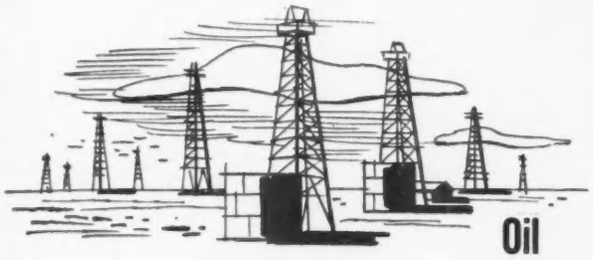



FIGURE 5—Development of basal Pennsylvanian sands, Harper Ranch pool, Clark County, Kansas.

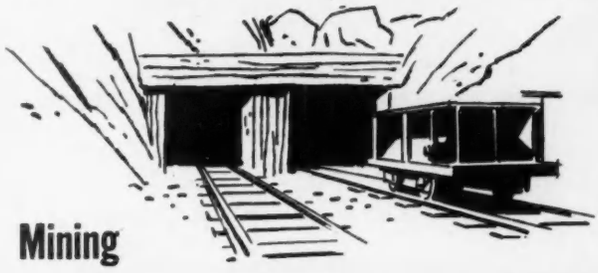
**If you're in any of these fields . . .**

Marine


Oil

Construction

Agriculture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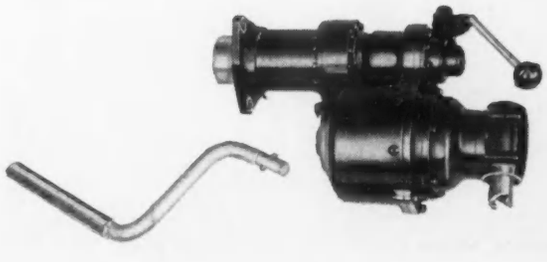

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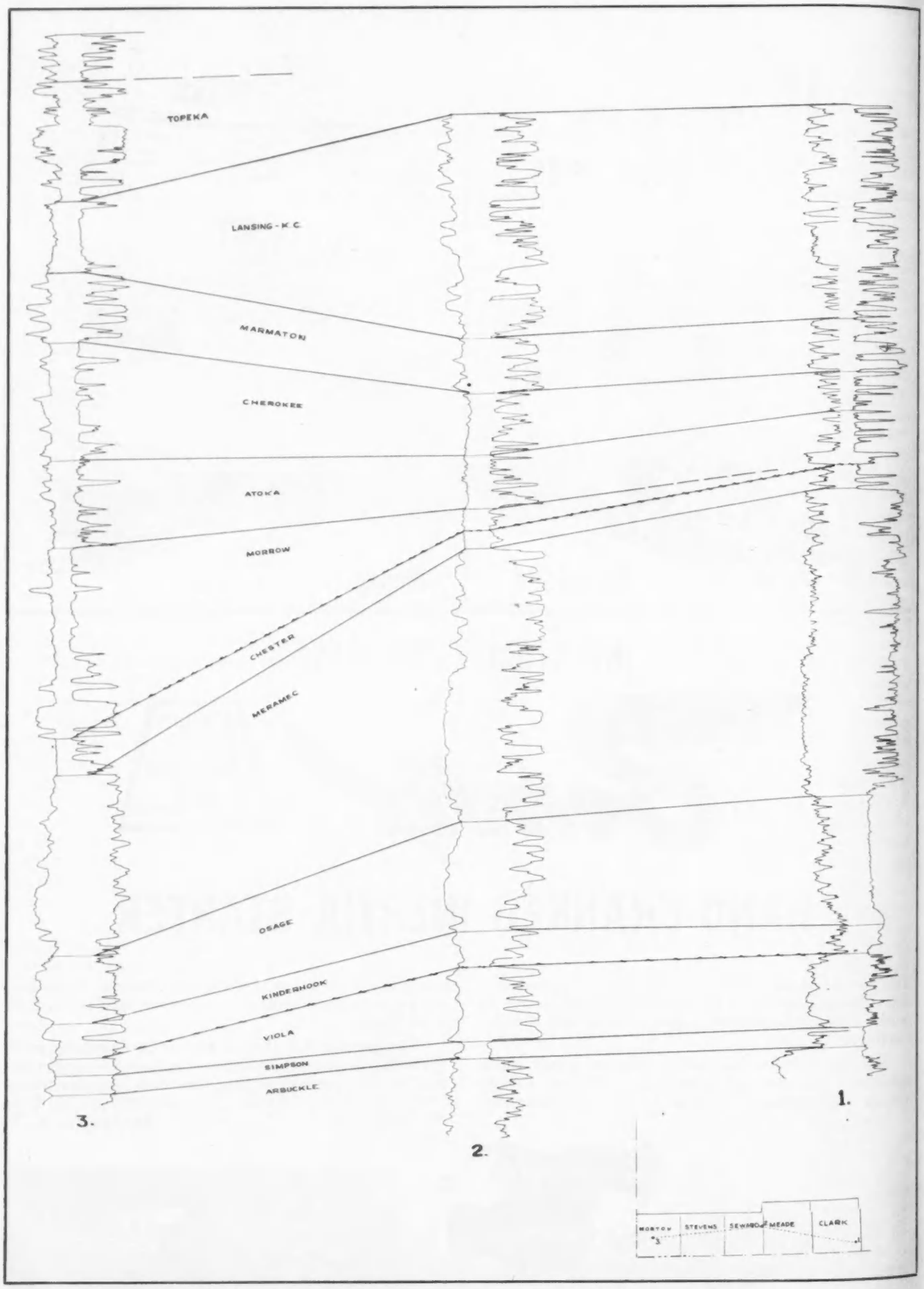
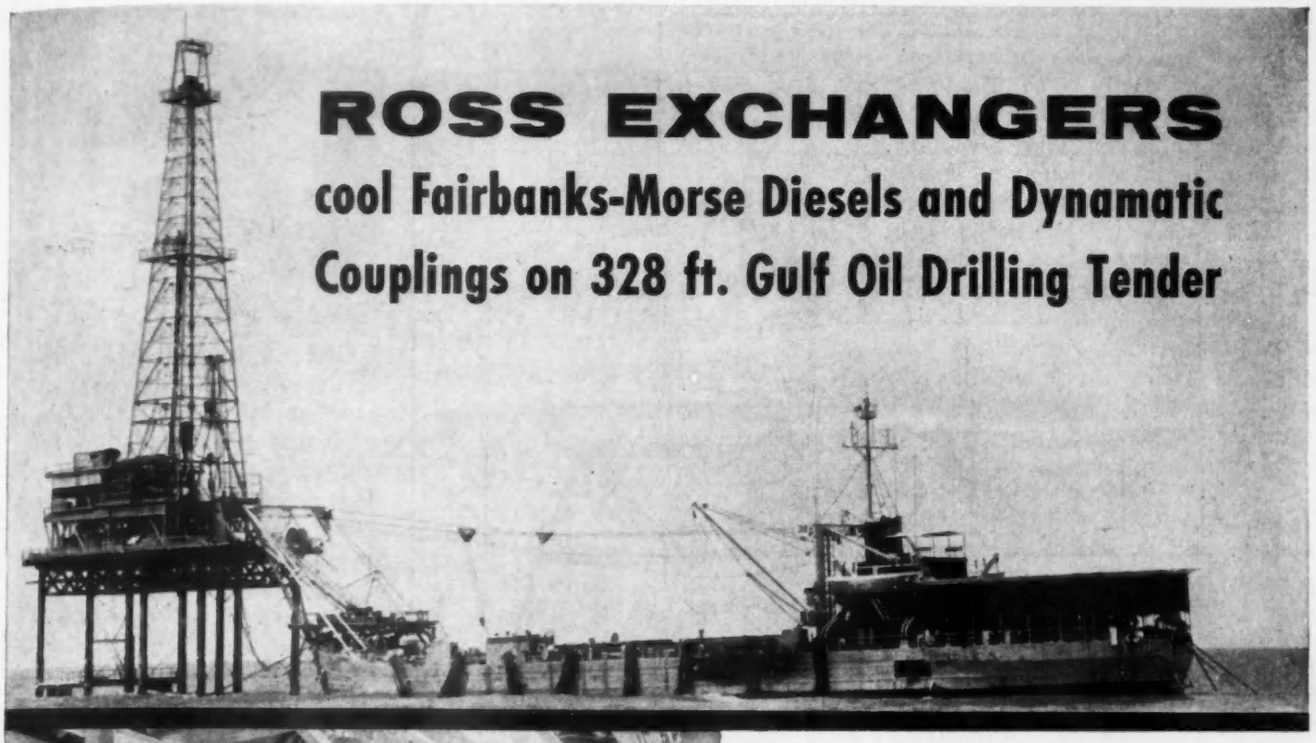
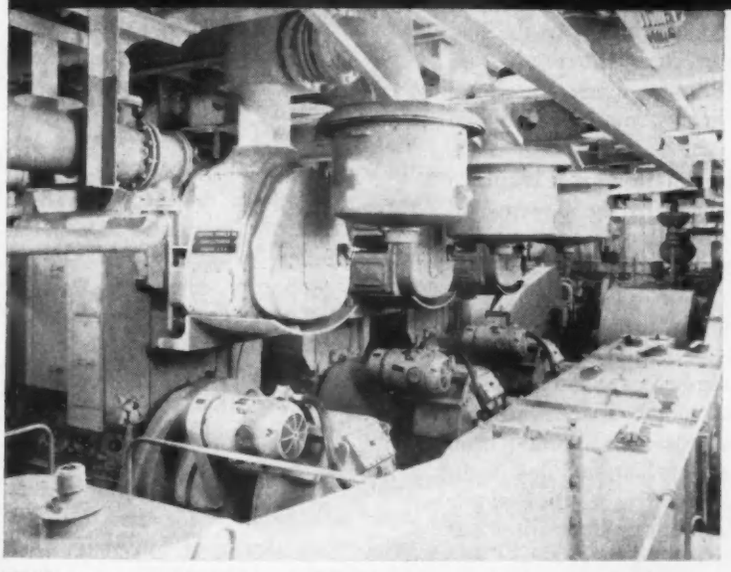


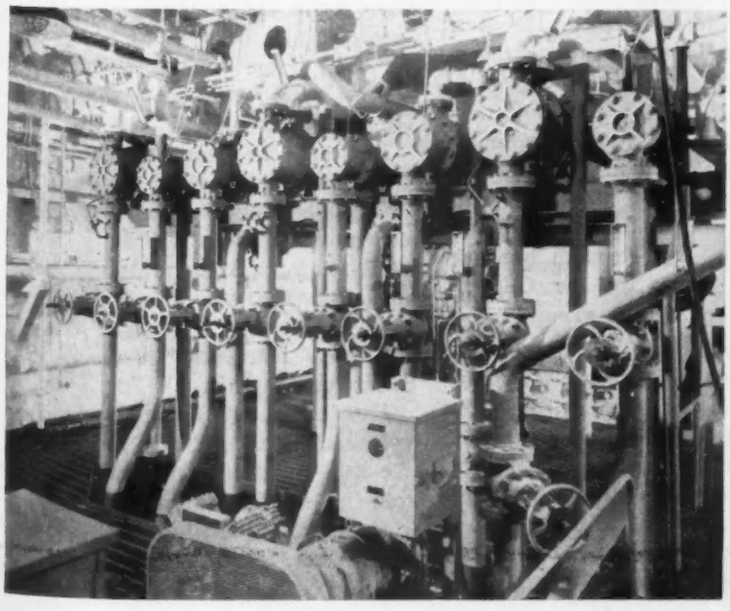

FIGURE 6—Regional west-east cross section, Morton County to Clark County, Kansas.

# ROSS EXCHANGERS

## cool Fairbanks-Morse Diesels and Dynamatic Couplings on 328 ft. Gulf Oil Drilling Tender







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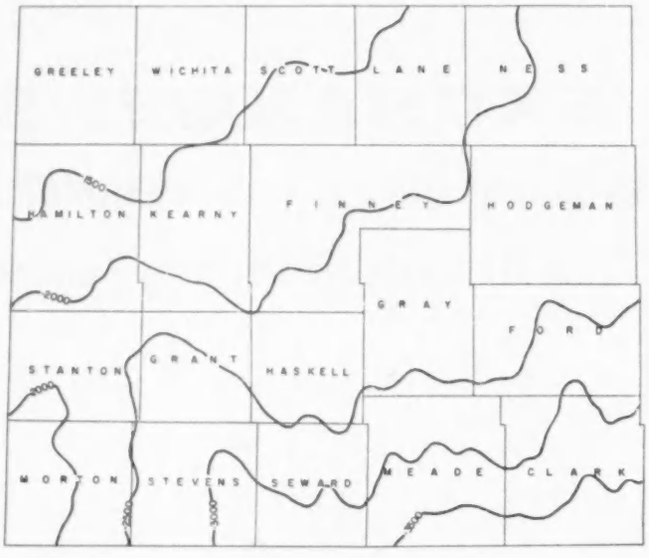


**FIGURE 7—Regional structure. Datum: Top Mississippian, C.I. = 500 feet.**

tan crystalline limestones with thin gray and black carbonaceous shales constitute the Lansing-Kansas City. Due to a lack of criteria in the area for division of the Lansing and the Kansas City it has been a common practice to lump the two together without differentiation.

Many of the limestone members have good vugular, oocastic and fossiliferous porosity. Local variations in porosity in conjunction with structure offers future possibilities in the area inasmuch as these beds exhibit good reservoir characteristics.

The group thins to the west as indicated on the regional cross-section. The section has undergone a facies change in the Greenwood Pool area of Morton County where shales are more abundant than limestones. The change to a shale and clastic facies is complete westward in southeastern Colorado.

• **Shawnee**—Two members of the Shawnee Group produce in southwest Kansas and therefore merit a certain amount of discussion.

The Toronto limestone is cream to buff, fine crystalline, with pinpoint porosity developed where productive. Several wells in the area produce gas from this member which is commonly represented by two or more porous sections. Even within local areas the limestones making up the Toronto vary widely in thickness, porosity and general arrangement of zones.

Although structure apparently has a bearing on production in some of the wells, it also appears that stratigraphic conditions are equally important. The carbonaceous shales of the overlying Heebner tend to give false readings on mud logging units which mask possible shows in the Toronto. In most cases the production is dry gas with no evidence of staining which complicates matters for the wellsite geologist.

The Topeka limestone as it is known where it produces in the Greenwood Pool of Morton County is a cream oocastic limestone, chalky in part. The same stratigraphic interval is represented by shale in the eastern portion of the embayment and therefore the top of the member cannot be picked. The limestone members continue farther into southeastern Colorado than does the Lansing-Kansas City indicating that the relative position of the two areas of limestone deposition was quite different.

**PERMIAN.** The Permian of the area has been widely discussed for many years as the Hugoton Field developed. The dolomites of the Chase Group are familiar to most as the producing zones in this vast field. Probably of future importance to the area, and little known, are the limestones which are present in the Permian beneath the Chase. These are the Council Grove and the Admire groups.

Limestones which are principally fine crystalline to chalky with pinpoint and oocastic porosity make up this section. Local variations in thickness and porosity are prevalent and gas shows in several wells indicate possible future reserves from stratigraphic traps in these intervals.

**CONCLUSIONS.** The Hugoton Embayment of southwestern Kansas represents an area where stratigraphic traps, due to facies changes, porosity pinchouts and truncation of porous zones, provide reservoirs.

Two of the more important producing formations which fit into this classification are the Morrow, which produces from lenticular sands, and the Chester, which produces from truncated porous limestones. Both are present in the central portion of the embayment and are normally principle drilling objectives.

Porosity variations and lenticularity in the limestones of the Pennsylvanian and Permian represent conditions contributing to present production in the area with promise for the future development. Areas of limestone deposition within the Pennsylvanian varied widely as can be seen by comparing the areal extent of the Lansing limestones (Missourian) with those of the Topeka (Shawnee).

The area has comparatively little structural relief. Present structure appears to be of secondary importance in forming most traps although a few pools are of a structural nature. In the latter case, however, it should be pointed out that the origin of these producing features was during pre-Pennsylvanian time.

The most promising exploration technique is a combination of intensive study of the sedimentation of the area together with the structural framework and the time relationship to the stratigraphic column.

—The End

## About the Author

GLENN F. THOMAS, district geologist for Lion Oil Company at Liberal, Kansas, was graduated from the University of Colorado in 1950 with a B.A. degree in geology. He then joined Ohio Oil Company where he remained until 1954. Thomas is a member of the AAPG and past president of the Liberal Geological Society.

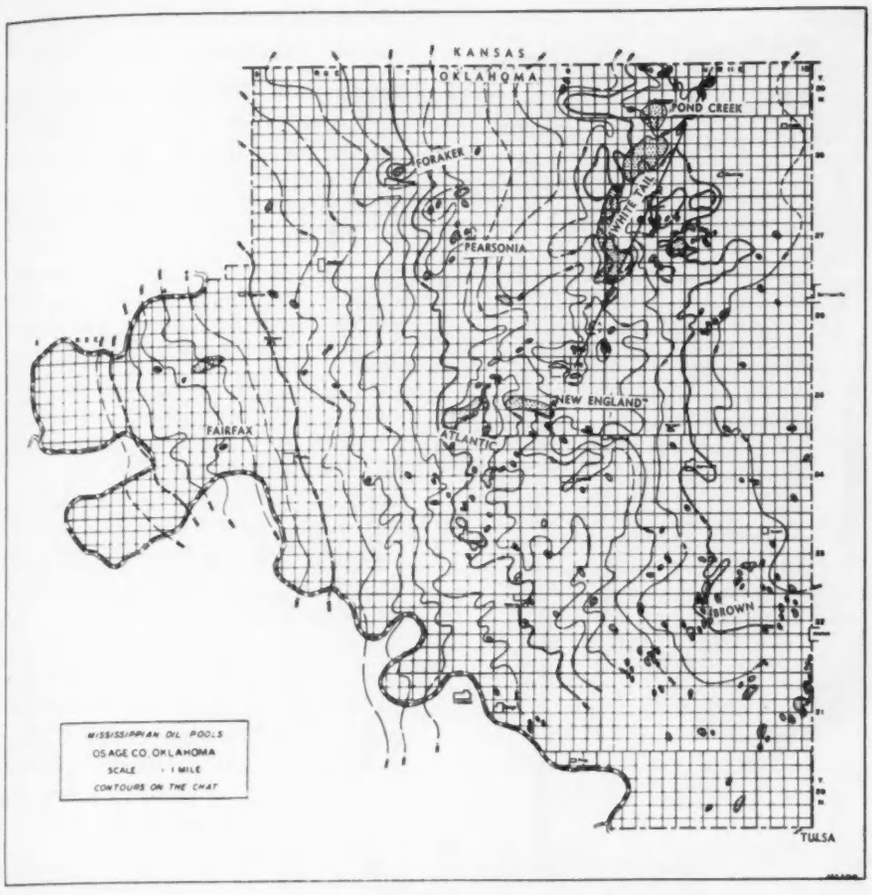


FIGURE 1

# Mississippian Production In the Osage

**The Mississippian horizon in this area has been productive since 1911. No Mississippian well can be considered a test until it has penetrated a greater part of the section.**

**By J. A. HAYES, JR.,**
National Associated Petroleum Company,
Tulsa

THE CONTROLLED BOOM that the oil industry has been experiencing in Osage County, Oklahoma, has been caused by the sudden realization by most major oil companies that the chat and limestones of the Mississippian series contain important quantities of oil at very shallow depths. The boom has not been confined to Osage County, for lease play has extended well into Kansas. In a band about 35 miles wide, from R-6E to R-11E, it extended nearly to Osage County, Kansas. Oil discoveries of any importance, however, have all been in Osage County, Oklahoma, up to the present time. In many cases the new production is not by way of a discovery, but by greatly extending old production that previously was not considered important.

The Granite floor beneath the sedimentary rocks of Osage County, is a very uneven one, judging from information on several wells that reached the granite. The area was emergent until late Cambrian time when the sea spread over the entire continent except a spot in western Montana, the Sierra Grande area in New Mexico, and the east and west coastal orogenic belts. These belts supplied sediments and precipitates for the Arbuckle limestone and reworked sandstone usually called the Hominy.

The Hominy was deposited unconformable on the Arbuckle, and in turn was covered by the Tyner (Ordovician) formation. This much history of this area is fairly certain, for in well samples is found the green shale of probable Tyner age on the dark Hominy sandstone of probable Burgen age, and this on the Arbuckle limestone.

The next formation encountered, in ascending order, is the Chattanooga shale, leaving the greater part of the Ordovician and all the Silurian and Devonian unaccounted for. It generally is assumed that sediments were deposited during most of these ages and that they were eroded from this area during or at the end of Devonian time.

It was during the Devonian period that the Chautauqua Arch of northeast Oklahoma, southeast Kansas, and the adjoining parts of Missouri and Arkansas became positive, tilting this region to the west. Erosion then leveled the rocks down to the Arbuckle in the east, and to the Tyner in the west. On these truncated formations the Kinderhook seas (early Mississippian) deposited the black Chattanooga shale. It is probable that the Chouteau formation and the Osage group from the St. Joe limestone through the Keokuk limestone also were deposited. Then at the end of Osage time the Osage Island, an area centered in the middle of Osage County, Oklahoma, rose above sea level. Subsequent erosion breached this dome almost to the Arbuckle. In Figure 2 one of the logs shows only 25 feet of shale between the Mississippian limestone and the Arbuckle dolomite.

The Meramec seas (Mississippian) then covered this area and deposited the Cowley limestone. This is the cherty black limestone so well known from well samples in the "Osage." Conformably on top of this the Warsaw formation was deposited. It is a white cherty limestone and when weathered is the "Chat." There may have been some Spergen, St. Louis and St. Genevieve rocks deposited during the remainder of Meramec time, but if so they were removed

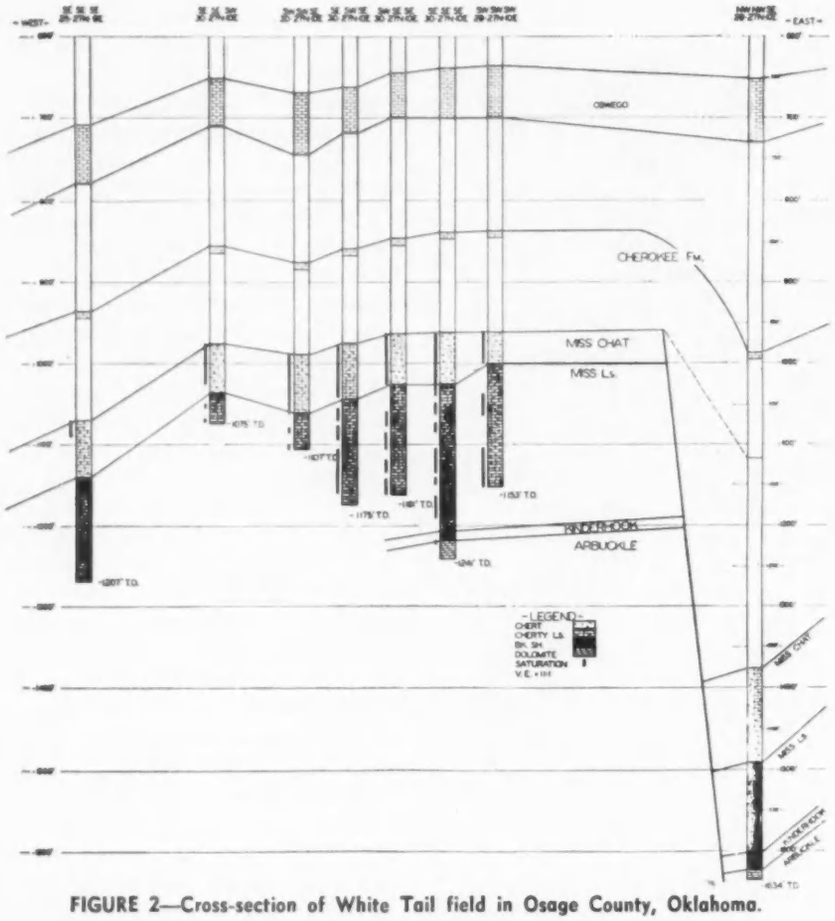


**FIGURE 2—Cross-section of White Tail field in Osage County, Oklahoma.**

along with any Chester rocks which may have been deposited, prior to the great submergence of the Pennsylvanian era.

The period between the Mississippian and Pennsylvanian periods was an important time for this area. To the west the Nemaha Ridge was born; to the east the Ozarks rose higher and this area rose well above sea level. Some folding and faulting occurred, and the Warsaw limestone was weathered until it became the "Chat" in many places. On the higher area it was removed completely, exposing the Cowley formation which was weathered until it became the black "Chat." There was some final tilting to the west, then the whole region was lowered below the Cherokee seas (Pennsylvanian). At this time the Cherokee basin of eastern Oklahoma was formed. On this deeply weathered surface sediments of the Pennsylvanian system were deposited.

The truncated edges of the Pennsylvanian rocks are on the surface of Osage County today, except for a narrow strip along the western edge where they are covered conformably by the Permian formations. Very little of the history since Permian time can be inferred from the rocks. However, there is some information in the northeast-southwest trending zones of en echelon faults that are present through the center of the county. Their cause is not clear, but the fact that one such zone overlies a known fault that had 300 to 400 feet of displacement in Mississippian and older rocks is a strong indication that this particular line of en echelon faults is the result of lateral movement of these older rocks along this fault plane (see Figures 1 and 2). This fault is shown in cross section in Figure 2.

It is noteworthy that the Oswego to Chat interval west of the fault is about 320 feet, whereas east of the fault it is about 420 feet. This increases to 500 feet at the eastern edge of Osage County. This interval immediately east of the fault has a much thickened section, as shown in Figure 2, and the extra section is entirely at the base of the Cherokee formation. In this fill is found many pieces of the black cherty limestone from the high side of the fault. The other zones of similar faults must have similar origins, even though the subsea elevations on the Chat do not indicate the presence of any faults.

**Production History.** Oil and gas have been produced from the Mississippian rocks in this area since the early part of this century. Most of the production was from the upper few to upper 50 feet. Main reason for this was the belief that pipe had to be set on top of the pay and the pay section drilled-in dry. The degree of success varied greatly not only because the pay section varied from pool to pool, but because completion practices varied greatly. Pipe rarely was cemented in the early days, and when it was, cementing equipment and procedures were poor. Consequently, all information on old typewritten well logs or completion cards should be questioned.

The best two sources of information on old production in the Osage are the two U. S. G. S. bulletins 686 and 900. It has been noted in these publications that oil shows had been found as deep as 175 feet below the top of the Chat and that at one time before 1920 the rule of thumb of the drillers was to drill at least 50 feet into the Mississippian limestone if oil shows without water were encountered in the Chat. However, until recently these reports have been ignored.

Bulletin 900 refers to this horizon as the "Burgess sand-Mississippian lime zone" because cable tool drillers nearly always called the top part a sand. It is pretty well established now that the southeast corner of the county is the only area that has Burgess sand overlying the Mississippian. The rest of the county has Cherokee formation, younger than Burgess, overlying the Chat with an onlap relationship.

One of the first fields to produce oil and gas from the Chat was Pond Creek in the north central part of T28N-R10E and the south central part of T29N-R10E. Production started in 1911 and, from the beginning, the Mississippian was the most important horizon. Gas and oil were obtained from the whole chat section which averages about 100 feet thick. The accumulation is according to structure but potentials are according to porosity and permeability of the pay at each well. Because oil from several other pays and oil from the Chat was commingled, no estimate of total recoveries from the Chat can be made. Initial potentials ranged from

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10 to 100 barrels per day and settled rapidly to a much lower production. Of 91 oil wells only 16 were still producing in 1938. Since then there has been only sporadic drilling, most of which was for sands shallower than the Chat, until 1951. At that time the Chat production was extended into section 31-T29N-R11E, but this too settled quickly and created no interest.

The next area of note to produce from the Mississippian was the Domes field. It lies in the west central part of T27N-R11E and the east central part of T27N-R10E. It is called Domes Field because structurally it is a group of small domes. The first successful wells were drilled in 1914, and both gas and oil were produced from the upper part of the Chat. The initial potentials were small, but a good many of these original wells are still producing.

Another area that produced some oil from the upper part of the Mississippian section is in the northwest part of T22N-R11E, the South Brown anticline. Only a few wells were successful, but in bulletin 900-A is found this remark, "A well near the center of the NE¼ of Sec. 17 is reported to have produced initially 1200 barrels of oil a day from beds that occur 160 feet below the top of the Mississippi lime. This well is unusual, because oil occurs deep in the Mississippi lime in only a few localities in Osage County."

The Pearsonia field in section 18-T27N-R8E, discovered in 1919, produces from the Chat. The most remarkable thing about this field is that one well was reported to have had an initial potential of 7000 barrels per day. In this area the Chat is mostly white chert with very little limestone associated with it. When fractured and weathered it can have porosities as high as 35 percent. There has been no recent activity here, and the field produces now about 80 barrels per day.

In the north central part of T23N-R8E is the Osage-Hominy field. One of its many pays is in the upper part of the Mississippian limestone. According to Bulletin 900-B the oil occurred in the top 60 feet. This bulletin also stated, "Several wells in widely separated localities found shows of oil and gas from 110 to 130 feet below the top of the Mississippi lime. These shows might be important . . ."

Up to this time best production from the Mississippian was on the Cold Spring Anticline (see USGS Bulletin 900C) and was named the Atlantic field. The discovery was drilled in 1920. According to Bulletin 900C, several areas had produced from 7000 to 8000 barrels per acre from the Chat by the end of 1937. It is estimated that by the end of 1955 more than 10,000 barrels of oil per acre will have been recovered from the Chat over parts of this structure. The pool is productive through a structural range of more than a hundred feet.

**Recent Development.** Importance of the Mississippi Chat as a producing horizon gradually has increased during the past few years. The rise has been slow because it seems that no two wells act alike, water bearing zones occur in saturated sections, often the structurally high wells make the most water, water is at different levels on different flanks of the same pool, a drill stem test of a few feet of oil cut mud can become a flowing well, zones with only a weak odor often make good wells and vice versa, and it is possible to cable tool through thick chat zones with a dry hole, which, when cased and perforated, will flow. These phenomena have kept many oil producers from considering the Mississippian as a primary objective.

The Whitetail pool, the area of most interest recently, demonstrates what the Mississippian Chat and limestones can do. The older wells in this pool were in the southwest corner of T27N-R10E and produced from the Bartlesville sand and from the top ten feet of Chat or perhaps a little more. This production was extended into the northwest part of T26N-R9E during the summer of 1954.

In the fall of 1954 a well in the NW¼ of 31-T27N-R10E found that 60 feet of well saturated chat lay below the top ten feet and had an initial potential of almost 600 barrels per day. This section was cored and had an average porosity of 32 percent. Subsequent wells were drilled deeper than just through the Chat and most of them found oil at various places in the black cherty limestone of the Cowley formation. The limestone pays are fractured zones and occur any place in this limestone.

It is now the practice in this area to drill 200 feet below the top of the Chat, or to about 25 feet above the base of the Mississippian limestone, and set pipe on top of any drilling breaks in the bottom 50 or 60 feet. The well in the SE SE SE 30-T27N-R10E (see Figure 2) was drilled into the Arbuckle, so pipe was set through the limestone. It flowed ten barrels of clean oil per hour natural when perforated in the breaks in the bottom 50 feet of Mississippian limestone. This well has an oil column of 120 feet over-all.

The well west of this one was perforated in the breaks above those producing in this one, and fractured. After the load was recovered the well flowed 70 barrels per hour.

It can be seen in Figure 1 that the productive area now extends north into sections 31 and 32-T28N-R10E and will join the Chat production in the center of T28N-R10E. It is shown on this regional structure map of the Chat surface that this pool is a ring of oil around the top of a structure closed against a fault. Down dip there is water in the Chat and limestone breaks. Up dip there is a little gas and water in the Chat. Probably the apparent Chat that contains water above the ring of oil is not of Mississippian age, but is reworked chert and limestone washed into areas that had been denuded of the true Chat and is of Cherokee age. Often this reworked chert has good shows of oil and cannot be told from true Chat in well samples, but it will produce only water. Production over this area varies somewhat but is dependent on the permeability at each well. Permeability in the Chat is dependent on degree of weathering, which over-all was fairly uniform, and in the limestone breaks it is dependent on degree of fracturing. The best limestone production is near the fault, presumably where the fracturing is most extensive.

Oil has been found recently in good quantities 230 feet below the top of the Mississippian in T25N-R8E, and good shows were found in the early days of development, as mentioned above, as deep as 160 feet in the Mississippian. So no well can be considered a test of the Mississippian until it has penetrated nearly the whole limestone section.

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# Slim Hole to Crowd Big Hole Drilling . . . ?

**Will the present giant rigs fade away? Or will slim hole drilling be subordinated by its limitations? The author gives his evaluation of these factors.**

**By G. C. MacDONALD**
Zone Drilling Supervisor
Gulf Oil Corporation
Wichita, Kansas

EVERY OIL PRODUCER in the world today is faced with the increasing cost of finding new oil. Several factors have contributed to these higher costs apart from the steady appreciation in the unit price of labor and material. The increased depth at which new reserves must be sought is one principal cost-increasing factor. In spite of increased drilling efficiency, which should reduce per foot drilling costs, most operators find a steady year by year increase in their per foot drilling costs. In many instances this unit cost increase is a result of deeper drilling.

Depth has a profound influence on drilling costs. A typical 3500-foot well may cost $20,000 or $5.70 per foot; whereas, an 11,200-foot well may cost $400,000 or $35.70 per foot, (Figure 1). Drilling costs vary from one area to another, but the rate at which costs increase with depth is rather uniform in all areas. Regardless of area, increased drilling costs per foot can be expected as deeper wells are drilled.

A part of these cost increases with increased depth is due to the increased time required to perform routine operations. Time and cost are almost synonymous in rotary drilling operations. Except for equipment wear and bit consumption, there is little difference in rig costs between hole making and standing idle; labor, overhead, fuel, insurance, etc., substantially are constant irrespective of activity type. It costs more to core, log, drill stem test, etc., at greater depth. A drill stem test at 5000 feet would cost approximately $590, and one at 11,000 feet approximately $950 (Figure 2). Although the total expenditures for drill stem testing may be but a small portion of the total drilling costs, the relationship of cost and depth is indicative of the trend in other activities.

Actual drilling cost increases are not the only factors contributing to the increased cost of finding oil. Poorer prospects are being drilled by many operators with consequent reduction in incidence of new discoveries. This results in a higher unit cost of new oil found. Certain areas of potential oil accumulation give very poor response to seismic endeavor and the results therefrom are unclear.

Much of the cream of readily identifiable structures has been skimmed from the potentially productive basins, and increased, hence more expensive, seismic effort is required to develop an equal number of prospects. Therefore, increased attention is being paid to subsurface geology as a prospecting tool. Core drilling to identify shallow structures has an obvious limitation and value if shallow and deep structures do not follow one another.

Regardless of the prospecting tool or tools employed, there is no substitute for a drilled hole; only in this manner can oil definitely be found. Serious consideration might be given to relying more on drilled holes for prospecting tools and less on other prospect evaluating techniques. The choice would largely be influenced by economic considerations, not the least of which would be the sure knowledge that a favorable prospect developed by other tools would require eventual drilling for final evaluation.

The degree to which work preliminary to drilling could be reduced profitably would be a function of many factors and proper decision could be reached only after careful and detailed analysis of each situation.

Preoccupation with economics rather than mechanics is a condition that has enveloped the drilling industry recently without visible evidence of the change in emphasis. With existing tools and techniques wells can be drilled to almost any depth from which petroleum can be profitably produced, but there is a considerable doubt that petroleum can be recovered at a profit from some of the wells costing as much as they do today.

Refinements in tools and techniques continue apace with consequent reduction in unit drilling costs, but diminishing returns are in prospect in that direction. A new approach to the problem is needed. Aggressive and positive thinking should pay dividends commensurate with the action resulting from that thinking.

There were no mechanical prob-

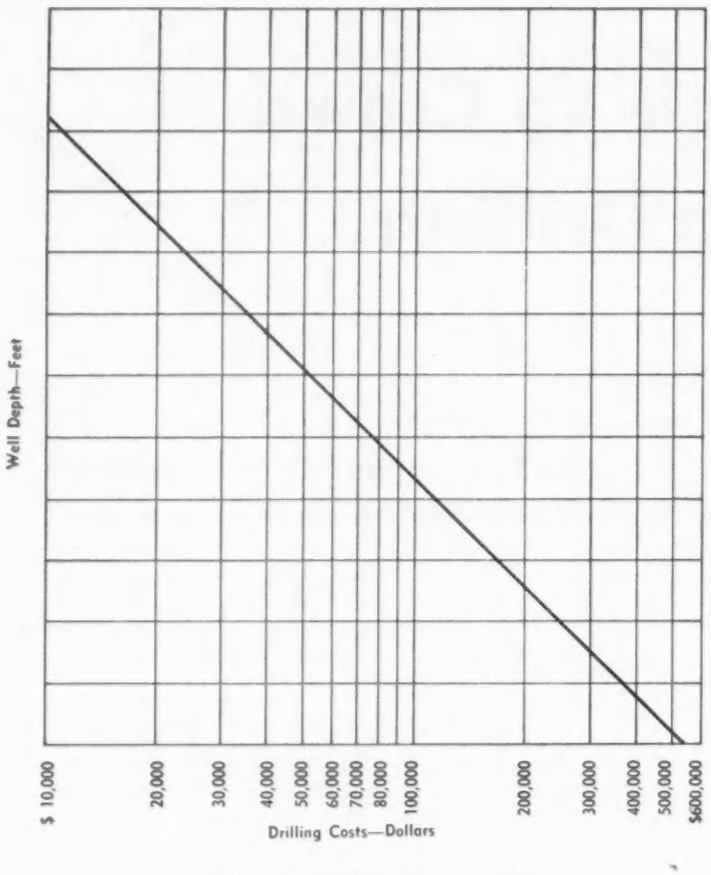


FIGURE 1—Drilling cost vs. depth.

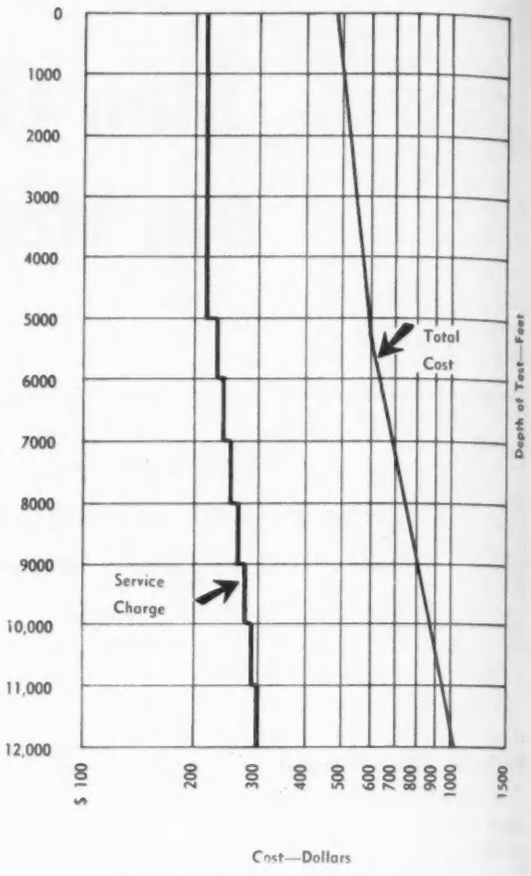


FIGURE 2—Drill stem cost vs. depth.

lems involved in drilling conventional 5000-foot holes in western Nebraska. Slim hole drilling success there was measured in terms of cost reduction. The tremendous problems of open sea drilling are those incident to site provision, supply communication, weather, etc., not drilling per se. The emphasis today in the field of drilling technology is on economics, a reduction in unit costs so that the total costs of the necessarily deeper wells can be held to an acceptable value. Unless that can be accomplished, oil finding may suffer.

It would be very easy to misinterpret the western Nebraska slim hole drilling success, by assuming that the mere reduction in hole size was responsible for the decreased drilling costs. Such an assumption, if acted upon, might soon discredit a promising new drilling technique.

There is ample evidence in support of the statement that a reduction in drilled hole size, with the same rig, increases drilling costs rather than reduces them. The cheapest hole a rig can drill is the maximum size of which it is capable to the total depth required. This fact is utilized every time a rig is selected for a given drilling job; the smallest rig capable of drilling the required hole size to the wanted depth is employed whenever a choice in rigs exists.

Drilling cost reductions do not flow from hole size reductions, but rather from the employment of smaller, therefore cheaper, equipment. Smaller bits are less efficient than larger bits, principally because of less adequate bearings and limited selection of tooth design; hence, slim hole drilling times may actually be longer than conventional hole drilling times. Operating costs of small rigs must be substantially reduced to absorb the longer drilling times incident to slim hole drilling.

Some items of cost are not subject to reduction with hole size. Supervision may actually be increased, at least until drilling crews become accustomed to the new technique. Automobile expense, office overhead, compensation insurance, etc., are not reduced when a slim hole is drilled. It is apparent that substantial cost reductions are required in the areas for which a potentiality exists if an over-all decrease in slim hole drilling costs over conventional hole costs is to be realized.

Slim hole drilling came to the drilling industry at a time when many thinking people were becoming increasingly aware of the fact that mere increased diligence in the application of existing tools and techniques had about reached the limit of cost reducing productiveness. Slim hole drilling was widely acclaimed and extensively employed because it offered possibilities of drilling cost reduction while still using familiar tools and techniques. The opinion was widely held that, overnight, and without altering equipment or techniques, the depth capacity of all rigs was immediately doubled simply because a smaller hole was to be drilled.

It is to the credit of the management of the oil company that pioneered slim hole drilling in western

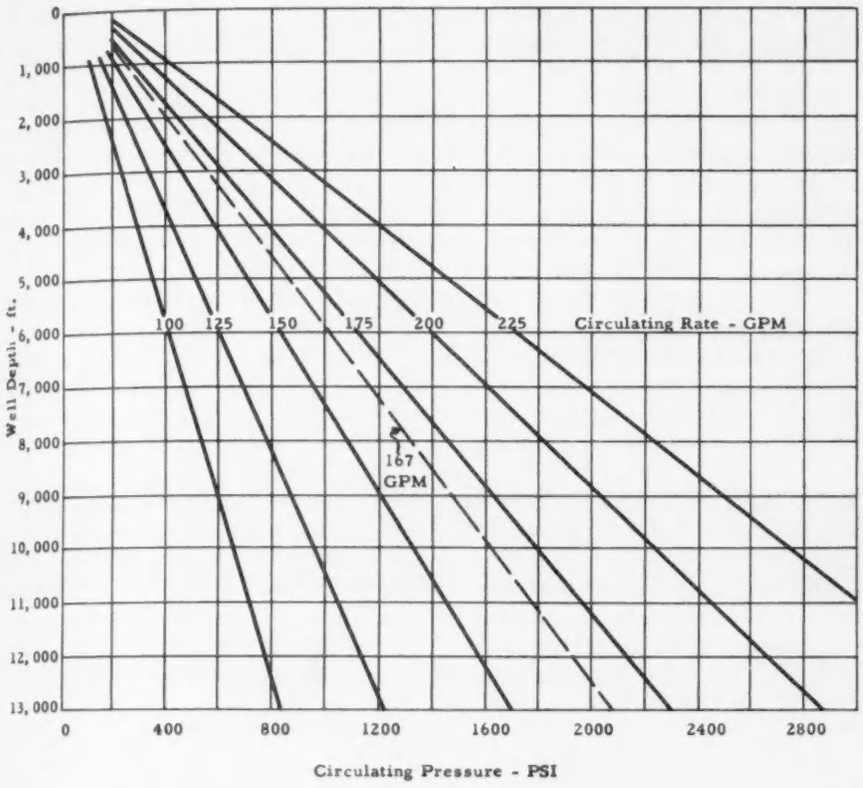


FIGURE 3—Total circulating pressure vs depth (including surface connections and annular return). Drill pipe: 2⅞" O.D. EUE 6.5 lb. tubing; Tool joints: 4⅛" O.D. x 2-7/16" bore; Drill collars: 10 4¾" O.D. x 2¼" bore; Hole: 5⅝"; Mud: 10.5 ppg 42 sec. 23 cp.

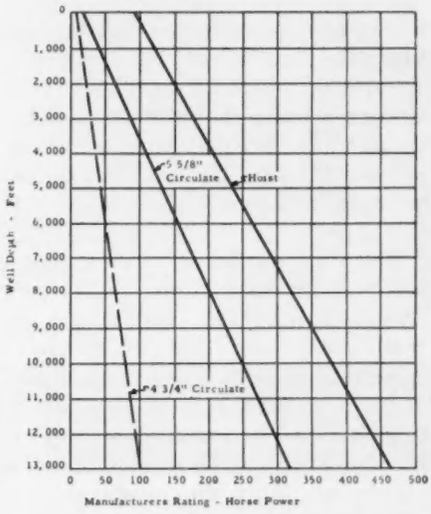


FIGURE 4—Installed HP requirements. Circulate—175 ft/min; Hoist—100 ft/min; 2⅞" O.D.—7.4 lb/ft tubing; 10—drill collars; Loss: 25 percent to pump, 33 percent to blocks.

Nebraska that such a favorable geologic environment was selected for the initial test area and that special equipment was assembled for the work. There is some possibility that this promising new drilling technique may be discredited through misapplication in other less appropriate geologic provinces, or through the use of conventional shallow, big hole equipment. The evolutionary processes through which big hole equipment has developed through the years may not be readily apparent because much of it resulted from slow trial and error procedures. It is now, however, highly specialized and appropriate only for big hole drilling. Slim hole drilling equipment and application techniques may be developed rapidly if the experience of big hole operations is applied properly to the problem.

Penetration of steeply dipping beds without the concurrent development of high deviation angles is one of the costlier drilling activities. Mathematical analysis and operating experience have indicated that an increase in drill collar diameter will provide a more rigid member above the bit and thus aid in maintaining a more vertical well bore. Stabilizers and reamers have been used to align the axis of the collars with the well bore, so that all bit weight would be applied as nearly as possible in a plane parallel to the axis of the well bore. Shell Oil Company used 11-inch OD collars in a 12¼-inch hole in Jumping Pound, Alberta, Canada, to combat high deviation angles.

The problem is to avoid high angles while employing sufficient bit weight to develop acceptable penetration rates. Large diameter, hence stiffer, collars help in that effort. Angles of eight degrees and ten degrees still occur and in many instances an operator cannot tolerate angles of that magnitude because of lease lines, size of objective, or contract limitations. Light bit weights, and consequent low penetration rates, are employed.

If the penetration rate is sacrificed for a more nearly vertical hole through the use of light bit weights, the cost of that hole possibly could be reduced by drilling it with smaller and cheaper equipment. The possibility of using solid diamond drilling bits at high rotative speeds and light weights has been tentatively considered for this type of drilling. If aggravated lost circulation is expected that only can be controlled through use of a string of casing, it would not be wise to penetrate the lost circulation zone with a slim hole. Slim hole drilling should not be applied indiscriminately.

The term slim hole itself is indefinite; it may mean a 7⅞-inch hole to one person and a 2¾-inch hole to another. The introduction of such subdivisions as "jeep hole," "peep hole," "ultra slim hole," "worn hole," "tap hole," "micro hole," etc., has not clarified the basic term to any recognizable extent. Surely the term should connote the drilling of a smaller than normal diameter hole. One responsible operator has for years set 4½-inch OD casing in some 9-inch holes drilled in southern Oklahoma, yet no one has suggested that these were slim holes.

What is a smaller than normal drilled hole size? A 5½-inch OD oil string is not unusual. The footage of 5½-inch OD shipped from the pipe mills over the past many years is approximately 120 percent of the 7-inch OD footage; hence, a hole intended to receive 5½-inch OD casing must be considered conventional.

A workable definition of a slim hole is: A drilled hole too small to receive 5½-inch OD casing. On that basis

probably a 6¾-inch hole would be the smallest that could be considered a conventional hole and then only in areas of competent rock. The hole size might be much larger through other less competent beds and still be considered a slim hole.

Anyone embarking upon a slim hole drilling venture should be thoroughly aware of the fact that, without enlarging operations, he has relinquished the possibility of casing with 5½-inch OD pipe.

Once the restriction of providing a hole large enough to receive 5½-inch OD casing has been cast off, the potentialities of cost reduction in exploratory drilling are within reach. Many of these exploratory holes will be dry, possibly an increasing percentage if drilling costs can be reduced sufficiently to justify the substitution of more drilled holes for currently employed exploratory tools. The over-all objective is the finding of oil; development work can be handled by conventional rigs.

Fundamental principles, developed through conventional drilling experience, apply equally to slim hole drilling. Drill pipe and drill collars of an outside diameter too large to be washed over or fished can be run only on a calculated risk basis. They are run on that basis in both conventional and slim holes constantly whenever the expected benefits are commensurate with the hazard involved. Shell Oil Company's use of 11-inch OD collars in a 12¼-inch hole in Jumping Pound field, was one example of this. Higher bit weights, and hence higher penetration rates, resulted from the use of the stiffer collars.

The 4¾-inch hole drilled by so many slim hole drillers with 2⅞-inch OD tubing or drill pipe represents the same sort of calculated risk; neither can be externally fished or washed over. A 6-inch hole is the smallest in which 3½-inch OD pipe can be washed over or externally fished, and a 5⅜-inch is the smallest for 2⅞-inch OD drill pipe or tool joint equipped tubing.

Tool joint equipped 2⅞-inch OD N-80 tubing is a popular drilling string. Circulating pressures are lower than through drill pipe of the same outside diameter because of a larger bore through tubing tool joints than through API internal flush tool joints. The lighter weight tubing requires less hoisting power than drill pipe. It is used in either 5⅝-inch holes or 4¾-inch holes. The use in the latter hole size is on a calculated risk basis.

There is one very important advantage to the 4¾-inch hole. The quantity of mud required to produce an acceptable annular rising mud velocity between drill pipe and 4¾-inch well bore is reduced from that required in a 5⅝-inch hole. Since either volume is pumped through the same drill pipe to bottom, the pressure required to maintain an acceptable annular velocity in a 5⅝-inch hole is approximately double those required for a 4¾-inch hole. A return velocity of 175 feet per minute is produced in a 4¾-inch hole with 102 gallons per minute and in a 5⅝-inch hole with 167 gallons per minute. Total circulating pressures through surface connections, tubing drill pipe, and ten drill collars at 6000 feet would be approximately 530 psi in a 4¾-inch hole and 1010 psi in a 5⅝-inch hole; at 12,000 feet, 1000 psi and 1930 psi respectively.

This is an extremely important factor favoring the 4¾-inch hole over the 5⅝-inch hole and the one dominating consideration which justifies the calculated risk of the smaller hole. Existing small volume mud pumps have gear ends adequate to approximately 1000 psi discharge pressure, with suitable liner size. Larger pumps, with heavier gear ends, have larger diameter fluid piston rods and longer strokes. When liner sizes are reduced to provide for the small fluid volumes required, very rough pump action with high surge peaks each revolution results. The large diameter fluid piston rods occupy a disproportionate part of the liner volume on the instroke and none on the outstroke, resulting in drastic discharge volume variations between piston instroke and outstroke and consequent undesirable pressure peaks. A dummy rod on the opposite side of the piston would correct this fault but a host of other design problems would ensue.

For the present, to avoid gear end overloading of existing small volume pumps, a maximum depth of 6000 feet with a 5⅝-inch hole and 12,000 feet with a 4¾-inch hole exists unless special shock absorbing drives are employed.

However, it is common practice to run pumps in a known overload condition and accept the consequence of increased maintenance costs. Duplex pumps could be compounded to split the gear end load, or triplex pumps could be developed for the service indicated; but for the present no wholly satisfactory solution exists. Circulating pressures in a 5⅝-inch hole to depths down to 13,000 feet for various rates of circulation are shown in Figure 3. The dashed line for 167 gallons per minute is set out as that is the circulation rate required to produce an annular mud return velocity of 175 feet per minute. The drilling string is 2⅞-inch OD, tool joint equipped tubing above ten drill collars, and the mud is 10.5 pounds per gallon. The drilling string and the mud would be typical for central U. S. drilling. The high pump pressures incident to 5⅝-inch hole drilling are apparent. The lack of a suitable pump for these pressures is the chief deterrent to deep 5⅝-inch slim hole drilling today.

In spite of these limitations, a 5⅝-inch hole often is drilled in preference to a 4¾-inch hole. Some of the reasons are:

**1.** 5⅝-inch bits have more and better bearings.

**2.** Bit tooth design is better.

**3.** A discovery well may be cased with 4½-inch OD standard coupled pipe.

**4.** Testing and logging tools are readily available.

**5.** Horsepower requirements for circulating, while higher than for a 4¾-inch hole, are more nearly equal to hoisting requirements which result in a higher engine utilization factor.

**6.** A hole smaller than 5⅝ inches might fall into the tax classification of a stratigraphic test.

**7.** 2⅞-inch OD pipe, tool joints and drill collars can be washed over with 5-inch OD, 13.00-pound casing and overshot fished.

The installed engine horsepower required to hoist tool joint equipped 2⅞-inch OD tubing will be approximately equal from either a 4¾-inch or 5⅝-inch hole and in both cases is greater than the engine installation required to circulate. Other studies have indicated that approximately 66 percent of an engine's rated horsepower is delivered to the hook and approximately 75 percent is delivered to the pump pulley. Power requirements for hoisting 100 feet per minute and circulating sufficient fluid to develop 175 feet per minute annular mud velocity are shown in Figure 4. Typical mud, drill collar, etc., are included and an assumption of 10,000 pounds of hook, block, elevators, etc., is made. It may be seen that at 10,000

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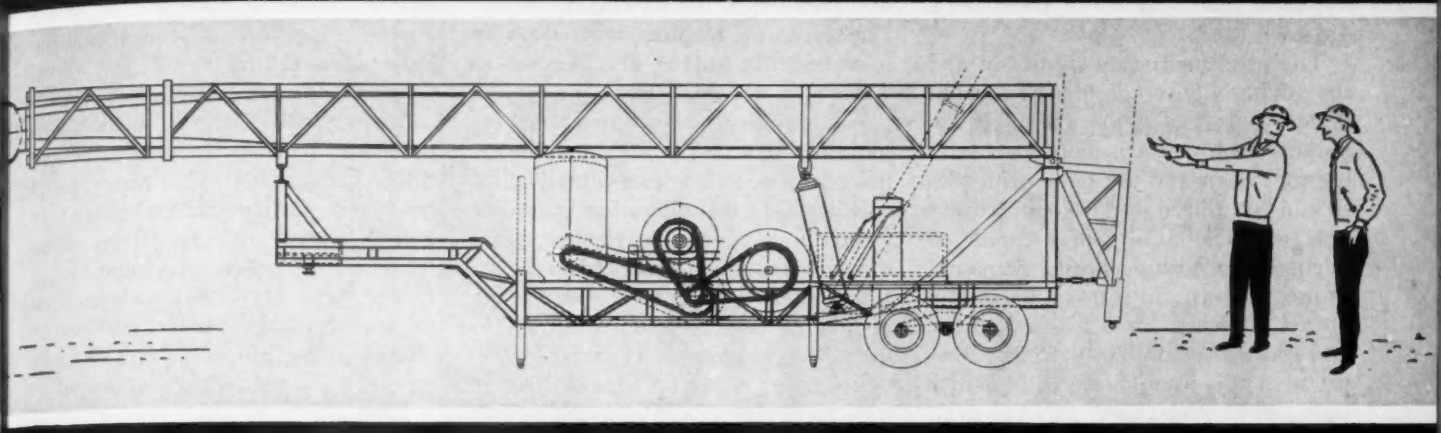

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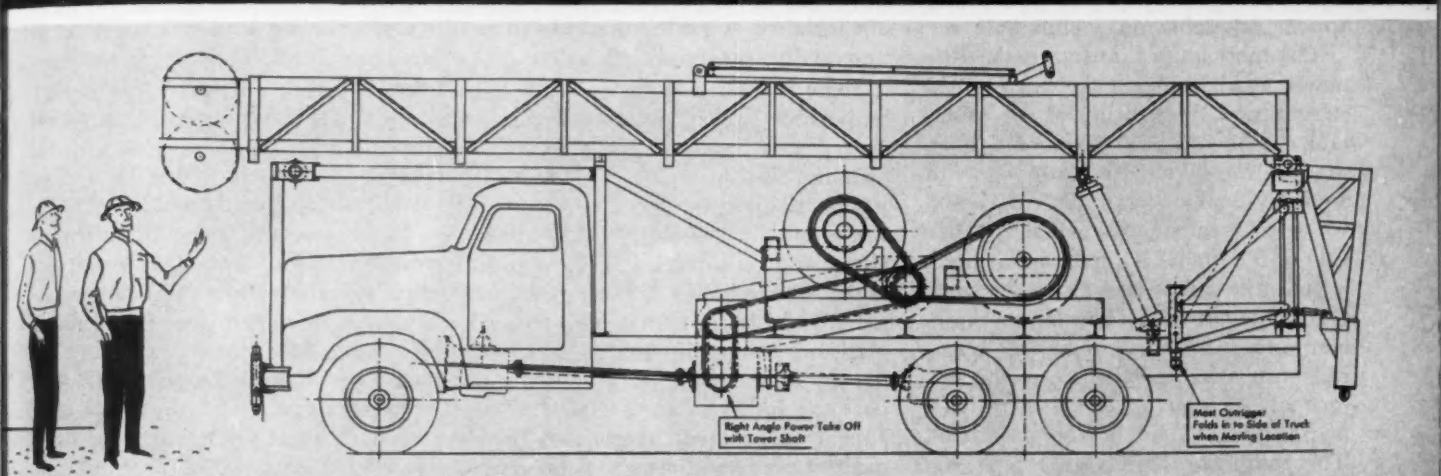


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feet it would require 380 horsepower to hoist, but only 250 to circulate a 5⅝-inch hole and 80 to circulate a 4¾-inch hole.

The need for special rig design and the advisability of considering, in that design, hole size to be drilled is apparent. Such consideration is given to big rig design and the same principles should be utilized in developing a slim hole rig. The draw works engine, if adequate to hoisting power demands, is more than adequate for pump power demands for a 5⅝-inch hole, and four times too big for pump service in a 4¾-inch hole. A 5⅝-inch hole can be circulated with the draw works engine without overloading it, and there is no reason for not taking advantage of the larger hole. Neither does an individually powered pump appear advisable on a slim hole rig.

The most important fact is that the power available from the draw works engine must be kept out of the rotary table. The usual conventional hole, shallow rig seldom is equipped with an individual rotary table drive, and while this is satisfactory when 4½-inch OD or 3½-inch OD drill pipe is used, it could be disasterous when 2⅞-inch OD tubing is used. The larger diameter and stiffer drill pipe will transmit unmistakable evidence to the surface of a hanging bit and permit appropriate clutch disengagement. The more flexible small pipe will merely wind up if anything like 300 or 400 horsepower is applied to the table. If the engine also is pulling the pump, the surface indication might be further obscured. One very successful slim hole rig has a 38-hp gas engine driving the rotary table through V-belts, and the owner considers the power adequate for 4¾-inch drilling to 10,000 feet.

There are other design features peculiar to slim hole rigs, which if not recognized may result in unsatisfactory slim hole drilling results. There is really no controversy between skid and wheel mounting advocates. A rig should be designed for the specific drilling conditions anticipated. There is no universal rig; a given rig can operate at maximum efficiency only under specific conditions.

A rig designed for movement over back roads or in foreign operations where no highway travel is involved could well be entirely wheel mounted as the movement of 90,000 or 100,000 pound loads would be no problem. A rig designed for considerable highway travel should be capable of disassembly into packages capable of legal loading in the area to be drilled. The highway loading restrictions in some of the states are shown in Table 1.

A slim hole rig is primarily an exploratory tool and as such may be required to negotiate exceedingly difficult terrain. Consideration might be given to designing the rig for movement in small skid mounted units, for transportation on small trucks. Length of time on each location would determine the seriousness of a few additional hours of rig up time on a small packaged rig. The placement of anchors and guy lines in hardpan or rocky ground often requires more time than is generally recognized: six men two full days had been observed in one instance. A guyless mast has many time-saving potentialities.

Some reduction in rig weight would be possible if there were fewer carryover practices from big rigs. There does not appear to be any valid objection to the placement of the draw works on the ground and the driller above and on a level with the derrick floor. The engine, draw works, and mast could be mounted on a base. A platform inside the mast, level with the top of the draw works, could support the rotary table. There does not appear to be much reason for carrying around enough iron to support the drill pipe at derrick floor level while it is out of the hole. The bottom of the stands could well rest on the ground, or skid base, instead of on the derrick floor during a trip.

Truck engines are often used, through power take-off, for driving various rig items. This is not too desirable because little automotive equipment is adequate to the continuous heavy duty service of drilling operation. One manufacturer has reversed this and made the unit self-propelled through a power feed from the heavy duty draw works engine to the unit wheels. There does not seem to be any reason why this practice should not be extended. The pump engine could move that unit; and the light plant engine, its own unit. Then if it were possible to have hydraulically retractable wheels so that each unit would sit on the ground during drilling, a number of problems would be solved, particularly the problem of a high pump suction lift resulting from the operation of a pump off a trailer. One operator at present is solving this suction lift problem by charging the pump suction through an auxiliary centrifugal pump.

Probably a higher percentage of slim hole than standard rigs will be owned by operators rather than drilling contractors. A slim hole rig is an exploratory tool and as such should be designed for a specific exploratory drilling program. Contractors normally are not advised of an impending exploratory program in sufficient time to provide themselves with the proper equipment in the right place at the appropriate time.

Some mechanical equipment needs revision when applied to small drill pipe or tubing; air tongs are helpful if equipped to grip tool joints instead of tubing. Most air tongs will not develop the 5000 foot-pounds of torque recommended for 2⅞-inch OD internal flush tool joints, but some newly developed hydraulic tongs may be satisfactory. Air slips provide the backup required for air tong operation, but it has been found that square shoulder tool joints will hit the top of some slips and drive them in.

Personnel also is a problem; some drilling crews consider the size of the rig indicative of the importance of the job and refuse to work on slim hole rigs. If slips are set as high on 2⅞-inch OD tubing as they have been on 4½-inch OD drill pipe, kinked pipe will occur when a connection is made. The "rat-hole" pipe must extend higher to lend support to the single for the same reason. The higher pump pressures incident to slim hole drilling generate crew apprehension until more experience is gained.

There are other problems, but none are insurmountable. It would be a mistake to apply the tools and techniques of big hole drilling; if the principles are utilized to develop tools and techniques suited to slim hole operations, more new oil should be found as a result of lowered exploration costs. —The End

**TABLE 1**

**Maximum Highway Loads Without Permits**

| STATE | Weight Incl. Tractor | DIMENSIONS | | |
|---|---|---|---|---|
| | | Height | Length | Width |
| Oklahoma | 60,000 lb. | 13′-6″ | 50′ | 8′ |
| Colorado | 73,600 lb. | 12′-6″ | 60′ | 8′ |
| Idaho | 72,000 lb. | 14′-0″ | 65′ | 8′ |
| Kansas | 63,800 lb. | 12′-6″ | 50′ | 8′ |
| Nebraska | 64,600 lb. | 12′-6″ | 50′ | 8′ |
| Montana | 76,800 lb. | 13′-6″ | 60′ | 8′ |
| Nevada | 76,800 lb. | | None | |
| New Mexico | 76,800 lb. | 12′-6″ | 65′ | 8′ |
| North Dakota | 57,700 lb. | 12′-6″ | 45′ | 8′ |
| Utah | 79,900 lb. | 14′-0″ | 60′ | 8′ |
| Wyoming | 73,900 lb. | 13′-0″ | 60′ | 8′ |

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# Porous Chrome Plating For Wear Resistance

**Lubricants have an affinity for this extremely hard metal, a combination that makes it ideal for re-surfacing worn and corroded wear surfaces.**

FIGURE 1—Prior to plating, the bores of power cylinders are honed to effect a smooth finish. Two honings are involved. After plating with porous chromium, the cylinder bore is honed to finished diameter.

**By GLENN PENDLEY,**
Van Der Horst Corporation,
Terrell, Texas

THE DEVELOPMENT of a new process that produces a chromium surface with wear resistant qualities plus an unusual affinity for lubrication promises prolonged bearing and liner service life. The wear resistance of a chromium surface is exceedingly high and, if economical lubrication could be obtained, the chrome surfaces would prove ideal for bearing and liner service.

Characteristics of this new chromium surface that contribute to reduced frictional wear are:

**1.** Hardness (approximately 1000 Brinell), which exceeds that of any other available material for liners and bearing surfaces. Hardness is maintained at high temperatures.

**2.** High thermal conductivity, which aids in maintaining low internal cylinder surface temperatures.

**3.** Low friction factor and low affinity for other metals, minimizing the heat generated at the surface under boundary lubrication conditions.

**4.** Corrosion resistance, which eliminates surface deterioration due to the action of the products of combustion.

Until now, chromium was not used for friction surfaces because of the impossibility of providing adequate lubrication, economically, to a chromium surface. A chromium surface sheds a lubricant, and for this reason has been undesirable as a cylinder surface. This new discovery is important, however, because now a chromium surface can be produced with the desirable characteristics which will:

**1.** Reduce cylinder wear in engines, compressors, and pumps.

**2.** Reduce lube oil consumption.

**3.** Produce material of maximum wettability which is easier to lubricate and keep lubricated.

**4.** Reduce the net area of contact between piston ring and cylinder bore, this in turn reducing cylinder operating temperature.

**5.** Make cheaper, more corrosive, fuel economically feasible because of the wear resistant qualities of a chrome surface.

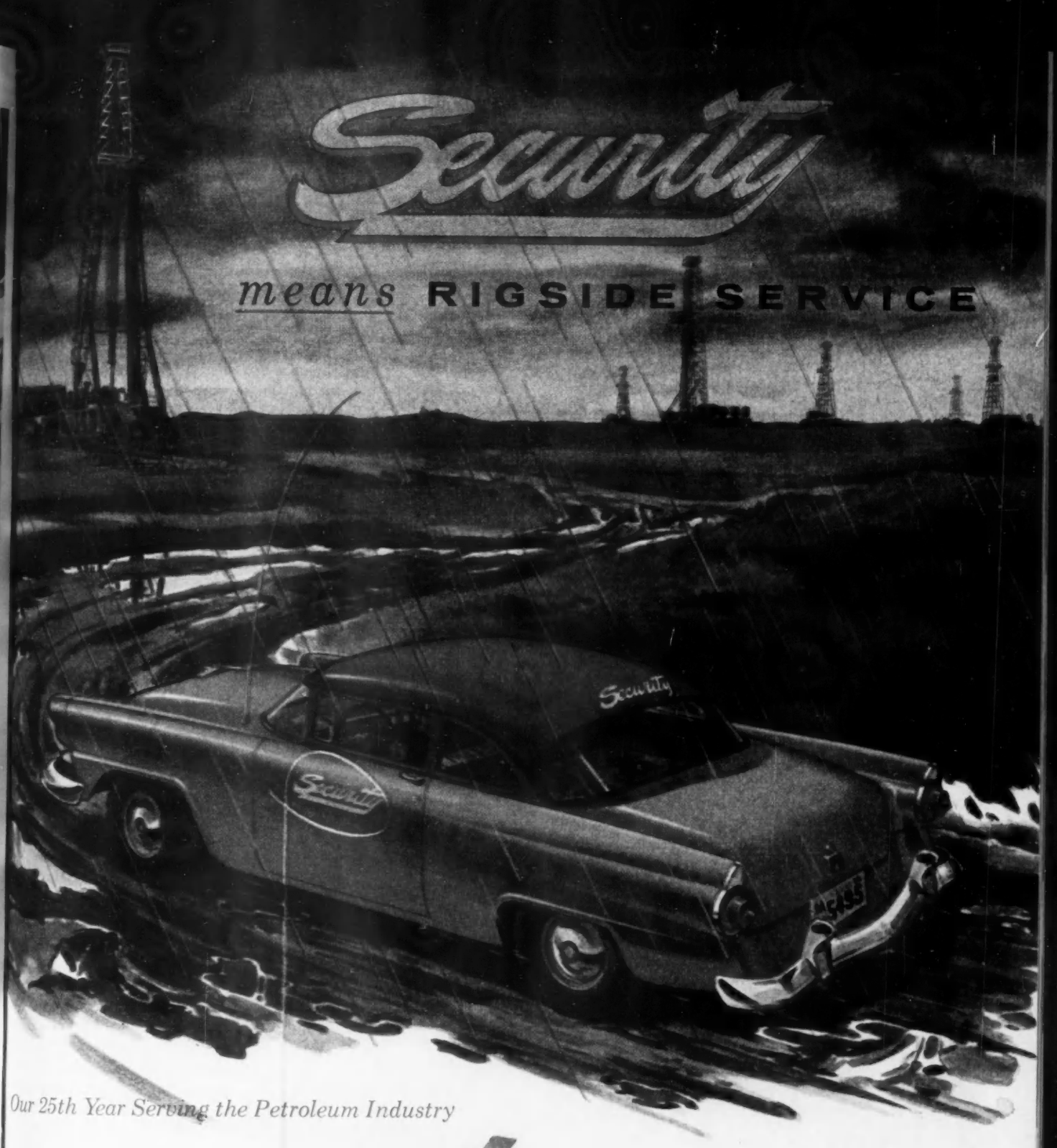
**6.** Provide low cost reclamation of both oversized cylinders and worn liners, eliminating the need for stocking oversize cylinders and rings.

To account for the difference between porous chromium and dense (non-porous) chromium it is necessary to understand the chemistry of electroplating. Electrodeposited chromium has a tendency to check minutely at the surface. These checks are referred to as stress patterns, and temperatures maintained in the plating process affect the depth and breadth of these checks to a limited degree. Once the stress pattern has been established, a reversal of the current flow in the plating process can be used to enlarge the fissures of the stress pattern and to eliminate existing stresses.

By a process of electronically controlled selective etching that removes chromium, not in even layers but by a further erosion of existing stress patterns, pores or channels can be formed on the surface of the chromium to create a porous surface of high wettability (Figures 2 and 3). The controls used in the process are so sensitive that depth and breadth of the pores or channels can be determined accurately. This "engineered erosion" can be controlled to range from 20 to 50 percent of the total surface area.

Microscopic examination of the surface structure of this porous chrome would reveal thousands of minute pores or channels that act as reservoirs when a lubricant is applied (Figure 3). This surface provides for the ultimate in wettability in comparison with steel or cast iron surface structures that have no potential oil reservoirs and therefore have less wettability.

Another advantage of this type of surface structure is that the factors producing heat on a frictional wear surface are speed, load and the friction characteristics of the opposing

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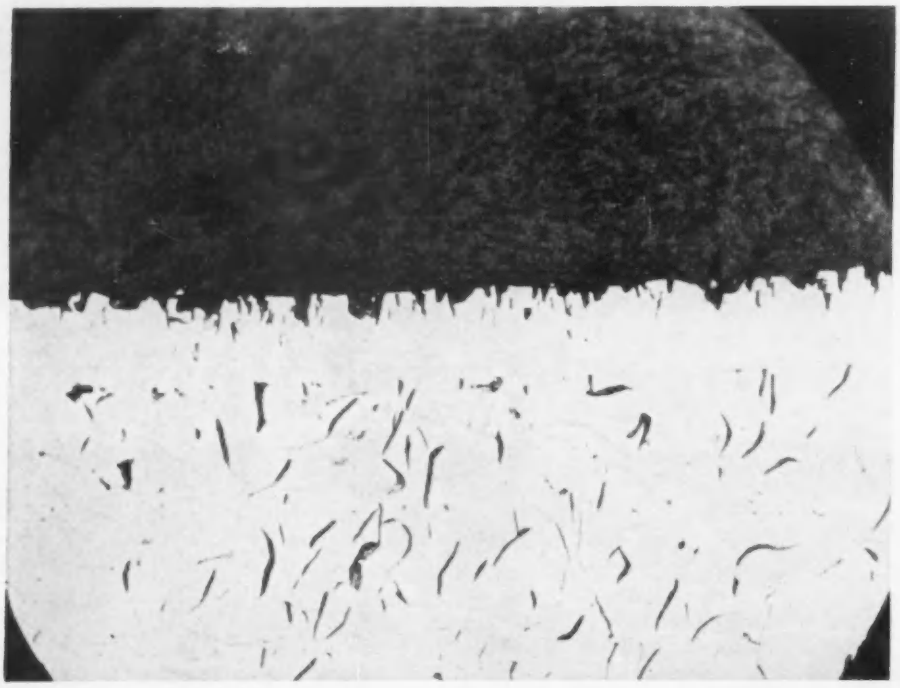

FIGURE 2—Pores and channels extend only partially into the total depth of porous chromium. Beneath these oil reservoirs dense chromium forms corrosion resistant barrier between the combustion chamber and the raw base metal of cylinders (magnification: 200X).

metals. Since the amount of friction depends to a great degree upon the actual net area of contact, the reduced surface area of the porous surface contributes to a reduction in cylinder operating temperature.

In addition to the increased cylinder life and lowered lube oil consumption possible with a porous chrome surface, an equally attractive economic factor is low cost reclamation of oversize cylinders by application of a porous chrome surface to the bores. An oversized cylinder bore can be restandardized in this manner, eliminating the need for stocking oversized pistons and rings.

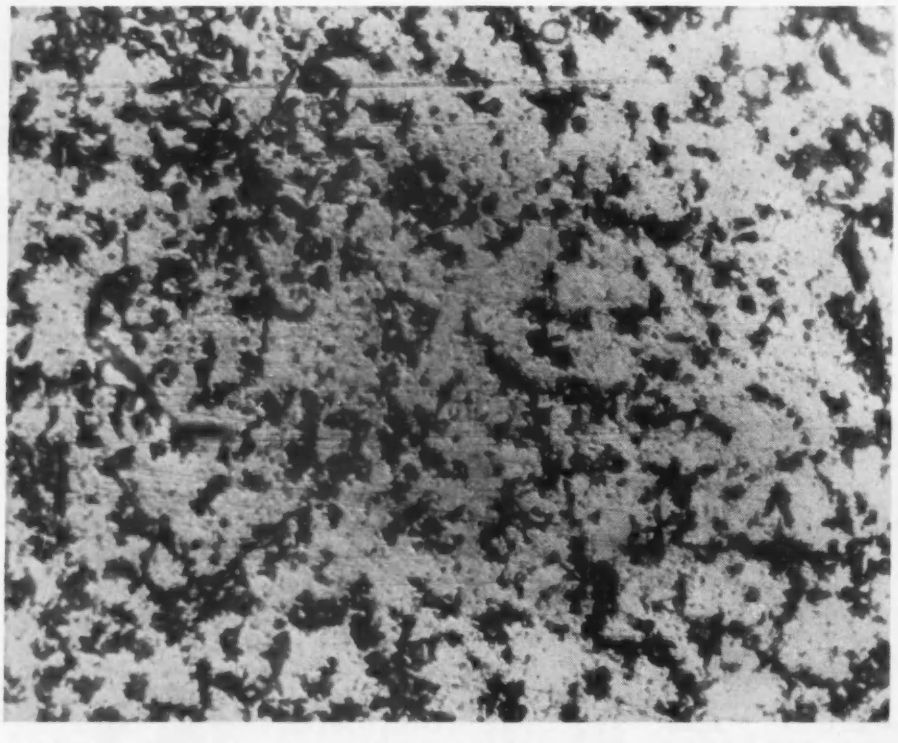

FIGURE 3—Surface view of pin point or pocket type porous chromium (magnification: 200X). Reduction in bearing surface contributes to lowered cylinder wall temperatures.

The railroad industry has accepted porous chrome plated surfaces for one of the reasons that diesel power itself was accepted so readily—lowered operating cost.

The necessity for scrapping a liner or using oversized pistons and rings is non-existant when porous chrome liners are used. Once the liner has been worn beyond acceptable limits it can be reprocessed to standard size with a new chrome surface.

In the marine industry, where downtime along a dock for engine maintenance is costly, porous chrome has won the approval of marine operators. One company used porous chrome in one of their ships as a proving ground for use of Bunker C as an engine fuel. Without regard for the sulfur content of the fuel, and in some instances sulfur content has run as high as 3½ percent, the test proved that savings resulting from the use of this cheaper fuel are considerable.

Demands of the petroleum industry, perhaps present the greatest test to power cylinders. For example, cast iron cylinders incorporated in pumping engines using sour gas fuel have an extremely short life, whereas identical pumping engines that have been equipped with porous chrome plated cylinders have lasted at least three times as long.

In 1952 the University of Houston's School of Diesel Engineering conducted an endurance test on porous chrome liners. A three-cylinder diesel was used for the test. Two standard liners and one porous chrome liner were installed in the engine. After 1000 hours of operation the cylinder heads were removed and the liners measured for wear. The results showed 0.002 inch wear on the standard liner and no measurable wear on the porous chrome liner.

Slush pumps operating under severe service conditions and delivering corrosive and abrasive material have a high maintenance cost. The chrome plating process would affect a tremendous savings around a drilling rig. Both engines and pumps are susceptible to corrosive and frictional wear. Not only would maintenance costs be reduced, but a reduced inventory of space liners and pistons and a great savings in downtime for repairs would be possible.—**The End**

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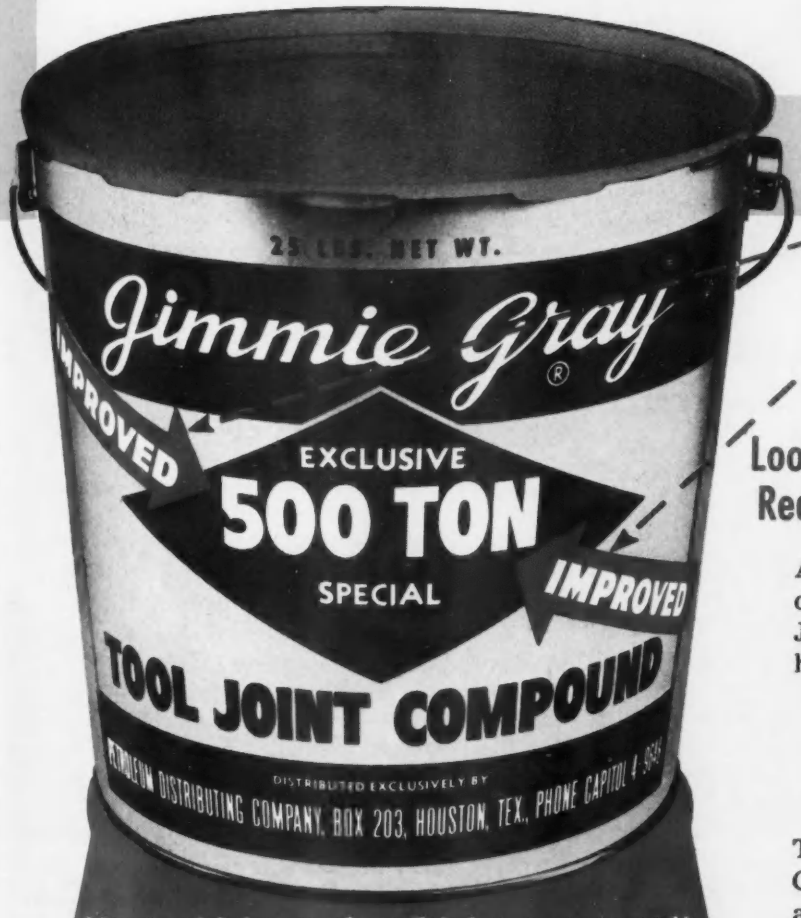


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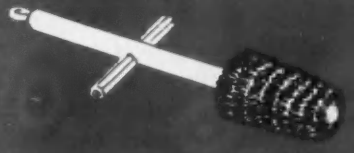

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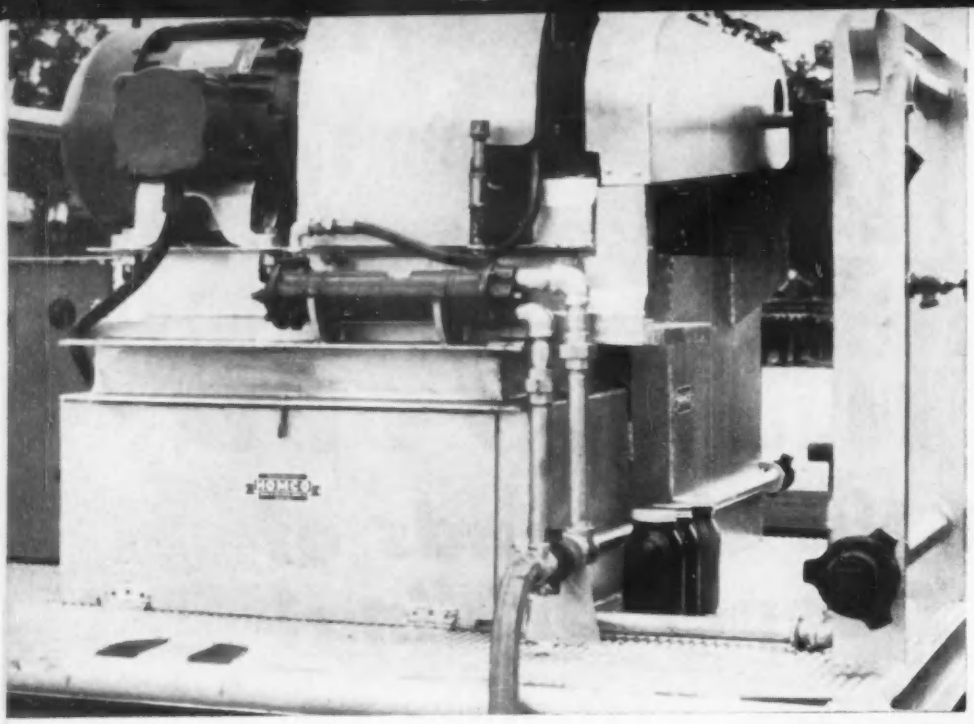


FIGURE 1—A 15-hp electric-motor-powered centrifuge developed for centrifugal separation of the drilled light clay solids from the barites so as to maintain a low solids, heavy weight drilling fluid.

# Evolution of Low Solids Drilling Fluids

**Lower mud costs, better viscosity control, and faster drilling rates are focusing attention on centrifugal separation.**

**By NASH O. CAMPISE,**
Houston Oilfield Material Company, Inc., Houston

DURING THE EARLY days of rotary drilling no one could have fully anticipated nor foretold the importance of drilling fluid in drilling the formations encountered today in deep oil wells. Drillers were concerned with one property only—viscosity. It was essential in maintaining the fluid in a pumpable condition and was achieved by dilution with water. Although drillers were unaware of it, this was the beginning of low drilling-solids content drilling mud.

Physical matter is an orderly part of nature. A group of laws govern its behavior just as it governs the behavior of the planets, the expansion and contraction of gas with heat and pressure, the reversion of steel to rust in the presence of moisture and oxygen, and other well known phenomena.

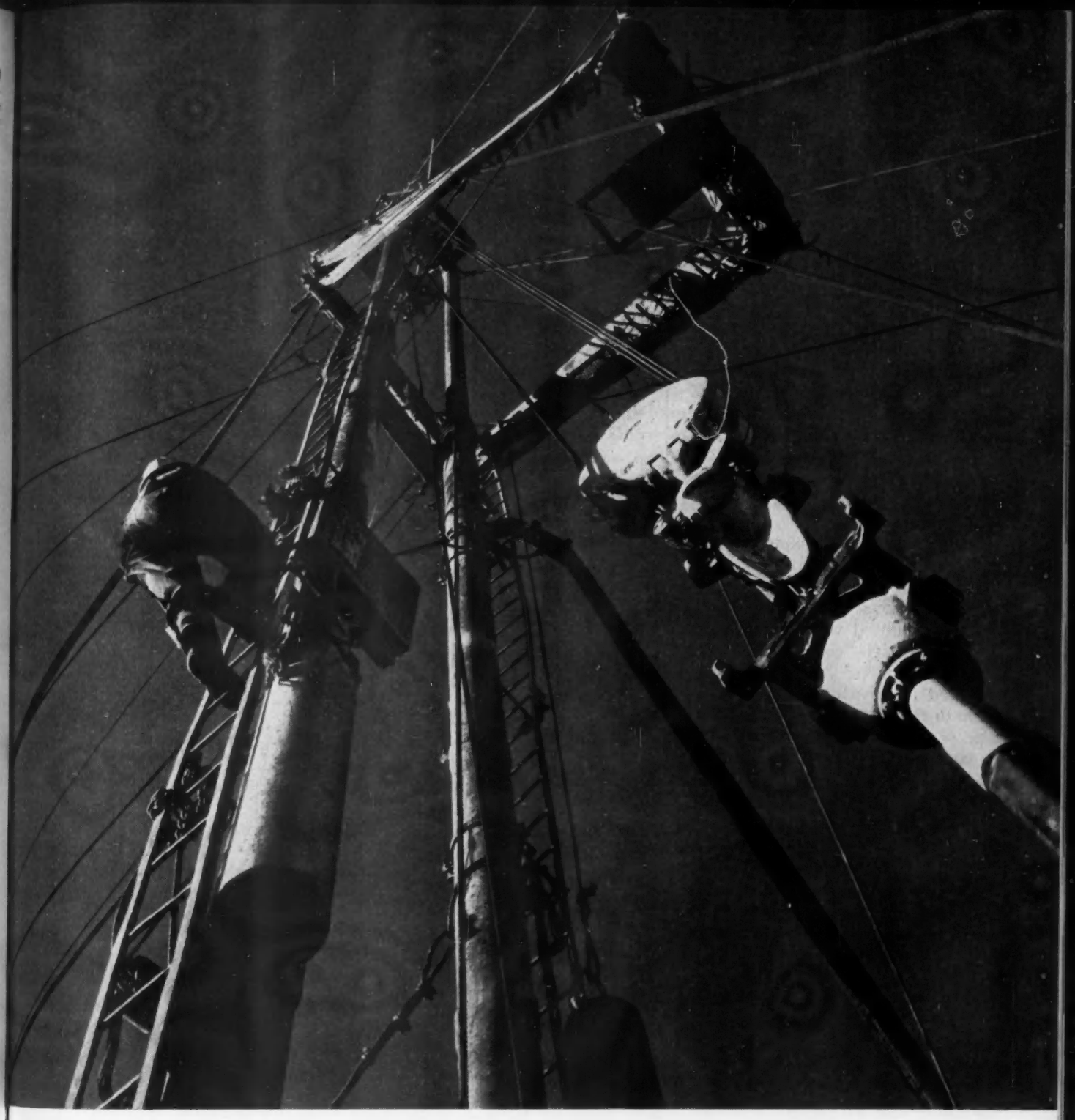
Accordingly, when clays are mixed with water the natural reaction is hydration; the clay particles absorb water, increase in size, and assume an electrical charge which produces an increase in viscosity. The extent of this viscosity increase depends upon the type of clay encountered. In some clays the reaction is almost negligible; these are called low yield clays. Others such as the swelling type of bentonites, have a pronounced increase in viscosity and are designated as high yield clays. Formation shales, lie largely in a range between these two.[1] The extent of viscosity increase is directly related to particle surface area, and consequently, is related to particle size and concentration. The smaller the particle size and the higher the concentration the more viscous the fluid will be up to the maximum of pumpability.

It has been shown time and again, that with all types of clay and water suspensions, the viscosity increase is not a straight line relationship with the percentage of clay.[2] For example, with low viscosity producing clays, described as low yield clays, approximately 30 percent by weight is required to produce a viscosity of 15 centipoises, but a 60 percent suspension of the same clay does not produce a 30 centipoises mud. Rather, it produces a fluid having a viscosity of 100 centipoises, or more. This also applies to the swelling type bentonites. A 4 to 6 percent suspension produces a fluid viscosity of 15 centipoises, while an 8 percent suspension produces a highly plastic fluid which cannot be pumped. This phenomenon is more pronounced in weighted drilling muds.

In the early stages of mud development, water dilution was employed to maintain low viscosities; and as fluid density was of little or no importance, this method of viscosity control sufficed.

When an increase in fluid density was necessary, barium sulfate was developed as a weighting material due to its inertness, high specific gravity, and availability. As it became necessary to increase mud weights, it became apparent that water dilution for viscosity control was dangerous; as it decreased the mud weight. Therefore, to combat high viscosity certain mud thinners were developed which consisted of the sodium salts of complex phosphates and tannins. Thinners, when applied in small amounts, reduced the viscosity without affecting the mud weight. These thinners solved the drilled-solids problem for many years.

As drilling went deeper and formation pressures became greater, additional increases in mud weights were required. It became necessary to use muds having weights of 16 to 18 pounds per gallon which reduced the available volume of space that drilled solids usually occupied. A 13 pound-per-gallon mud contains approximately 35 percent barite by weight; an 18 pound-per-gallon mud contains approximately 66 percent barite by weight. Thinners have a limited value in reducing the viscosity of high weight muds,[3] because they require large quantities of water plus weight-



**Wire Rope at Work**— They were at a depth of 2443 ft when this photograph was taken, and the plans called for going another 700. The formation was largely anhydrous. Located near Lefors, Texas, the well was being drilled by Frank Woods Associates, Inc., of Wichita Falls.

A light, portable type of rotary derrick served nicely for the fairly shallow drilling. The rotary line of the rig, Bethlehem 1-in. 6x21 Seale, was already a hardy veteran of oil-field service; it had to its credit six previous wells to depths of 3150 ft. This rotary line, by the way, was still going strong and gave every indication of staying in the thick of things for quite a while to come.

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ing material in maintaining density. As the density approaches 18 pounds per gallon, this method becomes more inefficient and expensive.

Mud engineers have developed a type of mud which reduces the hydration of clay particles by reducing the ultimate size of the particle. This allows the fluid to tolerate a higher concentration of drilled solids.

The theory underlying this method is known as the base exchange theory. Notable work has been performed along this line by several mud chemists.[4] The formation clays are sodium base clays and follow the pattern of hydration behavior described above. It is a well known fact that calcium clay particles exhibit less hydration effect than corresponding sodium clays under controlled conditions. Lime, the least expensive and most available source of calcium, can be added to mud with proper preconditioning. The initial reaction is to increase the viscosity. This reaction is more pronounced when the original viscosity is high; consequently it is becoming standard practice to dilute the mud to obtain a low viscosity, prior to the addition of lime.[5] This type of treatment allows heavy muds to carry a higher percentage of drilled solids and is accepted as the answer to the high solids problem. High bottom-hole temperatures which produce a non-reversible solidification and a high concentration of solids are not favorable for rates of penetration. The greater the concentration of solids, the more pronounced the degree of mud solidification.[6]

Mud chemists now recognize two sets of requirements: (1) Minimize clay hydration and (2) maintain a low concentration of drilled solids in the fluid.[7]

The first requirement is solved by the use of lime base muds. In solving the second requirement, the latest development in drilling mud treatment is the centrifugal classification for the mechanical separation of the heavy barite and the disposal of the lightweight drilled solids.

Bobo and Hoch have conducted extensive tests using a decanting type centrifuge for mechanical separation of barites and drilled solids.[8] They report that its practicability and economy have been proved in field operation. McGhee has reported considerable savings have been affected recently by using muds from which the drilled light clay solids have been removed.[9] These muds affected a saving of as much as 25 percent in drilling time and a 20 percent decrease in the number of bits used. Prior to the introduction of the centrifuge, low solid muds were maintained only by water dilution which is admittedly an expensive method.

*When using centrifugal separation, the viscosity and the gel strength of a mud can be maintained at a lower value than by dilution.*[10]

As mentioned earlier in this article, viscosity increase is not a straight line function with relation to concentration of drilled solids. Extensive data illustrating this has been recorded in drilling mud laboratories. For example, a 15.5 pound-per-gallon mud has a viscosity of 22 centipoises in a suspension having a 2 percent bentonite concentration.[11] This same weight mud has a viscosity of 37 centipoises in a 3 percent bentonite suspension; and a viscosity of 70 centipoises in a 4 percent suspension. Further, a 17 pound mud has a viscosity of 32 centipoises with a 2 percent suspension; 63 centipoises at 3 percent suspension and is non-pumpable with a 4 percent bentonite suspension. In reviewing these data it is evident that it is not necessary to remove all the drilled solids, but only the excessive quantity. Beyond a certain concentration a rapid increase in viscosity and yield value occurs. This concentration varies in different formations. Experience in the particular area is the best criteria for any mud treatment.

The centrifugal method available today removes not only the excessive amount of clay and other colloidal particles, which causes rapid increase in viscosity, but also returns approximately 95 to 98 percent of the barite to the mud system.[12] Centrifugal methods currently used have discarded up to 18 pounds of drilled solids per minute, or approximately 6400 pounds, in a 6-hour period.

It is generally agreed among mud chemists that water is the optimum drilling fluid with regard to penetration rate, but for obvious reasons water alone is used only in rare instances. Stanolind has shown the increase in drilling rate made possible by eliminating drilled solids in a series of tests in the Midland Farms field of West Texas.[13]

To further illustrate the high regard that mud chemists have for a low solids mud, Dodge, Atkinson, and Sedor of Shell Oil Corporation began using lime muds in 1948 as this type of mud maintained a high degree of tolerance for light solids.[14] They believed that drilling rates could be increased by using a mud having a lower solids content. They proved this to be true in the first few wells drilled with low solids red mud in 1952.

To summarize, drilling muds have progressed from a fluid in which all suspended solids were drilled solids to a fluid which is synthetic, with only a minimum of drilled solids being allowed to remain.

Mechanical separation is the latest development in a long and impressive line of mud treating techniques which have evolved through the years.

**About the Author**

NASH O. CAMPISE graduated from Rice Institute in 1939 with a B.S. in chemical engineering. Since graduation he has been employed by HOMCO and is now a technical consultant. He is a member of the API, and is a Registered Professional Engineer.


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# What's the Economic Limit?

**Jet bit penetration rate limits have not been reached. But in seeking the maximum operating potential offered by this tool, the operator must decide . . . what is the economic limit.**

**By R. M. BORDEN,**
Assistant District Manager, The National Supply Company, Edmonton, Alberta, Canada

AN IMPORTANT QUESTION among oil well drilling contractors today is—"What is the economic limit for additional equipment in a jet bit operation?"

There are varied answers to this question because of the heterogeneous factors involved. And until much more field study is done, the question must resolve itself into an area problem.

On the credit side of the problem are two important features—a greatly increased penetration rate and as much as 30 percent longer bit life (bearings) as compared to conventional bits. The steadily growing use of jet bits during the past two years is tangible evidence of increased efficiency and output.

By use of a jet bit, more of the hydraulic horsepower developed by the pump or pumps is concentrated at the bottom of the hole, cleaning away the chips the instant they are cut, rather than leaving them for the teeth to regrind.

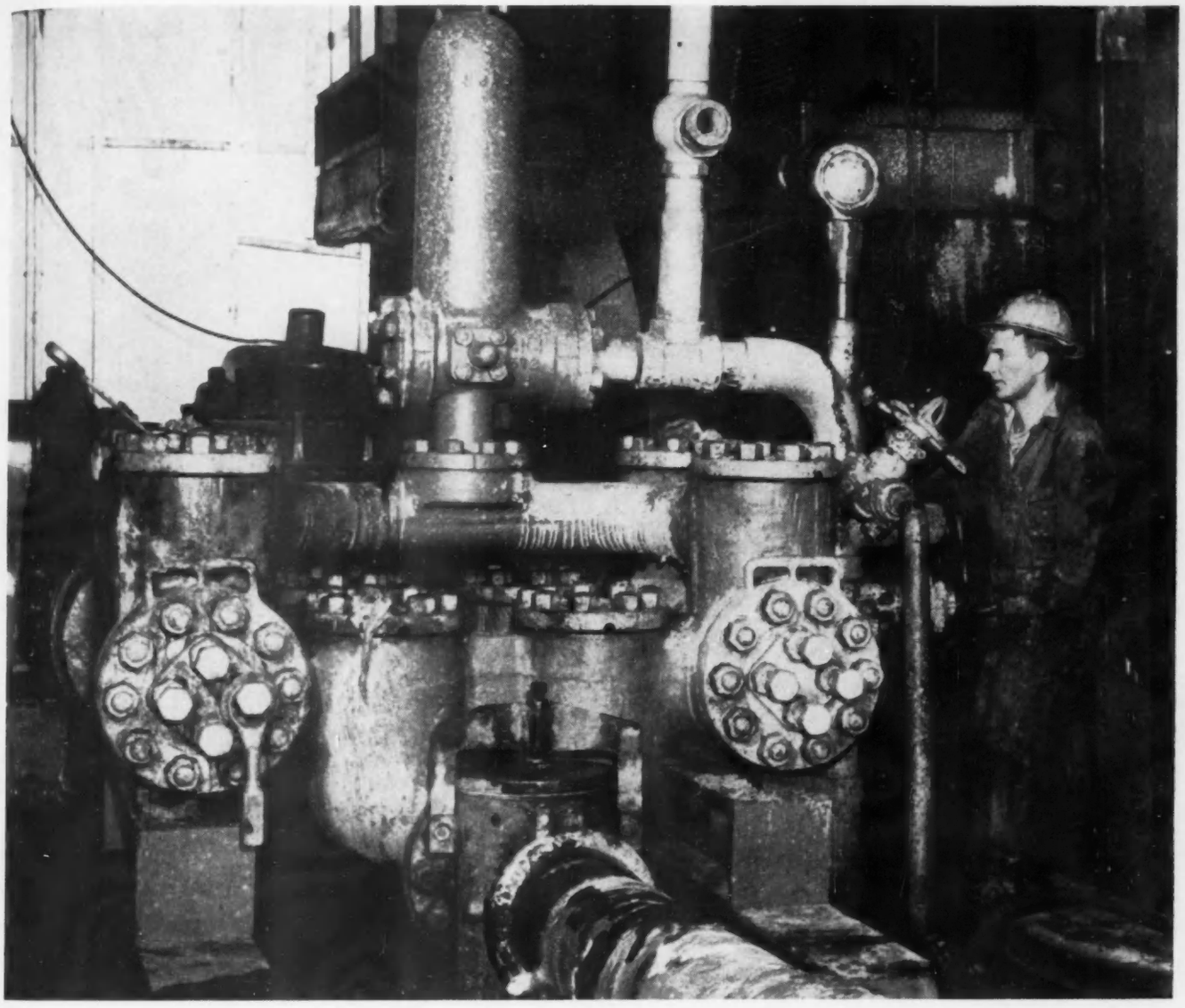
**The jet principle** of applying hydraulic horsepower in contrast to that employed with conventional bits might be compared to the use of a fire hose. With nozzle attached and turned to its smallest aperture (jet bit), the stream of water may be directed with great force at its target. Without the nozzle (conventional bit) the water flows free and easy from the hose.

When first introduced for use on existing equipment, the most common nozzle size was 9/16 inch, but drillers found that they could increase their hydraulic horsepower by using smaller nozzles—1/2 inch, 7/16 inch—and by raising their pump pressures. This, translated, meant an increase in penetration rate.

This practice created problems, however. Pumps which had been adequate for conventional bit drilling were being over-loaded on jet bit drilling operations, and consequently maintenance costs were increased.

It became evident that larger pumps would be required for effective jet bit drilling; the pump horsepower would have to be increased if the jet bits are used to full effectiveness.

**Other factors** must be considered, too, in determining pump requirements—drill pipe size, the size of mud flow lines, drill collar bore and mud pump efficiency—as all affect the net



**Efficient utilization of pumping systems is of basic importance in jet bit drilling. A reverse to former practice, the mud pump is now called upon for full capacity output from the surface down to insure delivery of maximum hydraulic horsepower to the jet bit.**

horsepower delivered to the drilling bit.

It is common practice today for pumps to be loaded from the grass roots down where formerly full capacity of the pumps was not reached until the wells were nearing completion or at some intermediate point determined by the liner sizes and engine horsepower, and then only for short periods. In terms of load factor, from 40 to 50 percent of the time a pump is in operation, it is working at full load. With a conventional bit, a pump is run at capacity about 20 percent of the time the rig is actually operating.

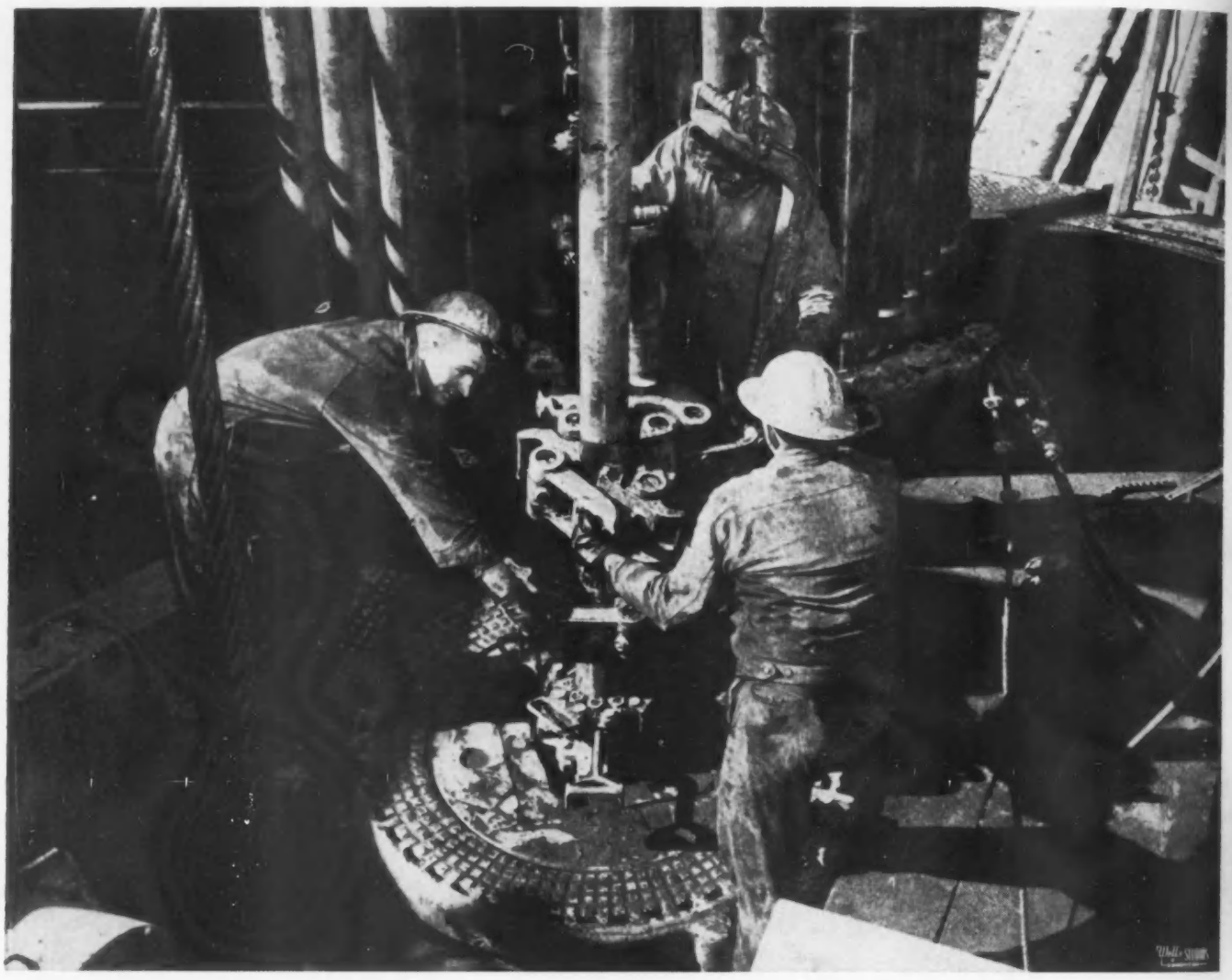
The first bit under surface now may be a jet bit with small nozzles and with pressures ranging from 1400 to 1800 pounds per square inch. And in oil well drilling, as in everything else, "you can't get something for nothing." The increased penetration rate of the jet bit is made possible only by an increase in operating costs.

If power is to be supplied at the bit, that much power and more must be supplied by the pumps; the added power to offset any loss which takes place in the drill pipe. Streamlining of rigs by replacing right angle bends in mud lines with sweep ells, enlarging openings through swivels and kellys, and by using larger drill pipe, will cut down this drill pipe loss and give more hydraulic horsepower at the bottom of the hole.

Although horsepower may be increased by multiple pump operation, as yet very little has been done in Canada; power requirements being being met by installation of larger pumps, larger engines and accessories; a high initial cost for jet bit operation. High maintenance costs, lack of trained personnel and scarcity of technical advice have been barriers to multiple pump operations in Canada.

**As an example** of some of the problems of multiple pump operation, here is what happens when two pumps capable of delivering 700 horsepower each are run in parallel. The total hydraulic load of both pumps is 1400 horsepower. If one pump of this operation is shut down the total hydraulic horsepower required to pump the mud through the system falls off from 1400 to 235, or to 17 percent of the original amount. The reason for this great reduction is that as the volume drops from 970 to 485 gallons per minute, and assuming the initial pressure was 2500 psi, the pressure with only one pump running drops to only 825 psi.

It can be seen from this example that if one pump is taken from a



**Here are important spokes in the wheel of jet bit operation: drill collars, drill pipe, rotary (speed) and crew, all planned and selected to do the proper job. It will result in increased penetration rates, increased profits.**

parallel operation the rig practically is shut down until the second pump resumes operation. In some cases it might be advisable to have three pumps tied into the same manifold. This arrangement provides a two-pump operation at all times, in the event of a shut down to the third. This, of course, is expensive.

In a series operation, if one pump is shut down, the remaining pump must be slowed down to 65 percent of its original rpm, so as not to exceed the rating. This means that where each pump was delivering 970 gpm, the remaining pump would have its output dropped to 630 gpm. The total hydraulic horsepower of the system with one pump is then 33 percent of the total horsepower of both pumps. It is possible, however, to increase the revolutions per minute of the single pump in the series operation so that an overload can be held for a short period, thus improving the delivered hydraulic horsepower during the time the second pump is out of service.

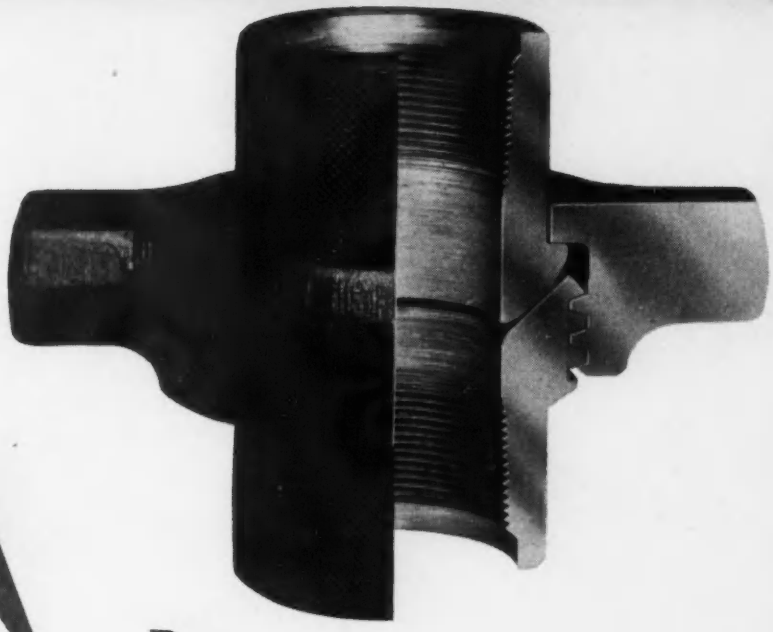
Maintenance costs go up with higher pump load factors, almost as a straight line function, with many operators as a result questioning the economic soundness of jet bit operations. In many cases this situation exists because contractors are not changing their operating methods when they use jet bits, and are placing too great a load on their slush pumps and related equipment.

**The operator** must analyze drilling problems in his area and consider the consequences of higher load with resulting shorter equipment life. Only by so doing, can he obtain higher returns from his pumps at higher loads. The drilling business is no longer a one-man show; it combines technology with field experience so that more holes can be made at lower rates with satisfactory profits.

Common sense operation at higher pressures will result in increased safety measures and clearer recognition of the requirements of a safety program. All equipment—flow lines and hoses, pressure relief valves, and drill string connections—which is subjected to high pressures must be carefully rigged and checked. Careless slush pump operations—valve cap studs without nuts, loose gland bushings, improper makeup of piston heads and rods—can result not only in lowered pump efficiencies, but can endanger both men and equipment. Increased pressure requires increased care, and there is no substitute for being sure.

Repeating the question! What is the economic limit for additional equipment for use in a jet bit operation?

Time and field experience will give the answers. —**The End**



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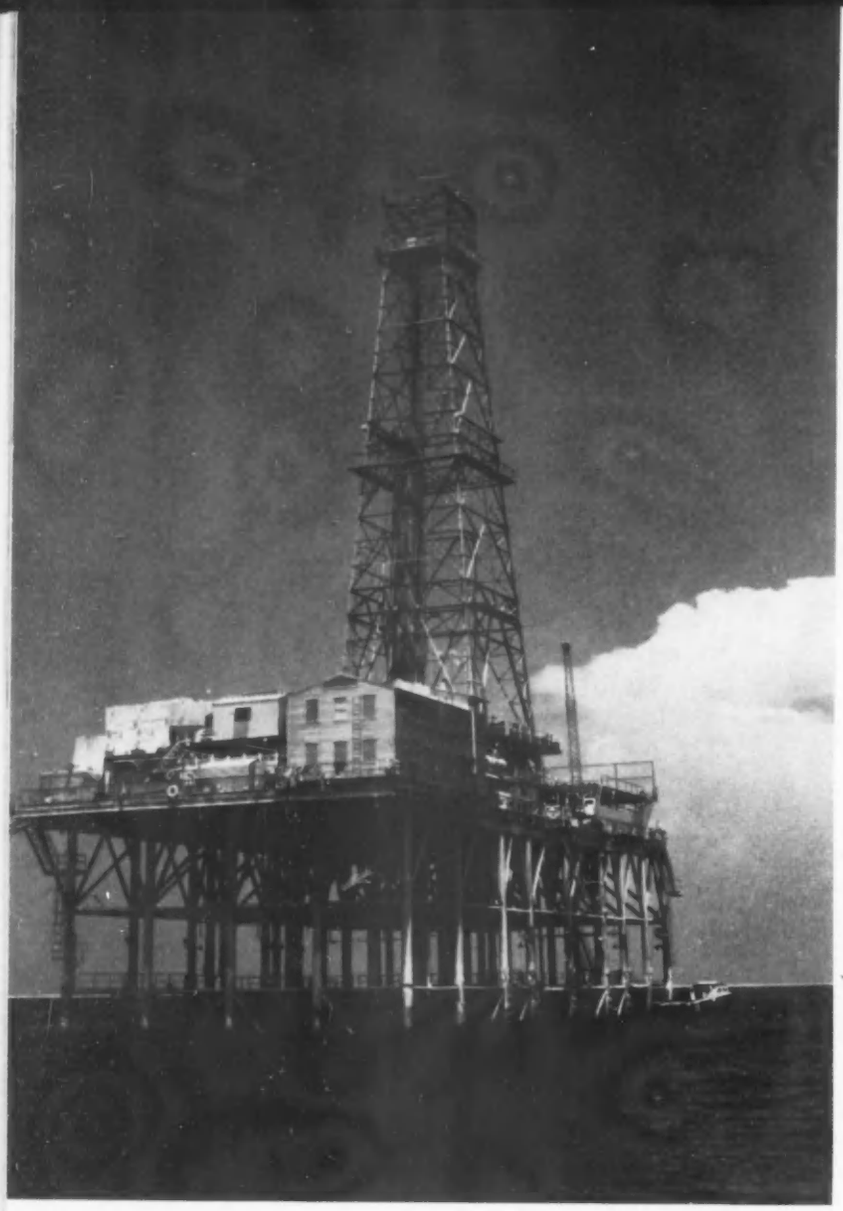


First permanent, self-contained drilling platform built by Shell Oil Company off the coast of Louisiana is this huge structure now sinking a wildcat well in 72 feet of water in East Bay, Block 42, near the mouth of the Mississippi river. From the bottom of its 460 foot piles to the top of the derrick is 650 feet—equivalent to the height of a 50-story building.

# Shell Completes Permanent Offshore Drilling Platform

**Twelve wells can be drilled from platform, drilling equipment removed and the platform used for production.**

THE FIRST PERMANENT, self-contained drilling platform built off the coast of Louisiana by Shell Oil Company is now sinking a wildcat well in 72 feet of water in East Bay, Block 42, near the mouth of the Mississippi river, the company announced recently.

The structure is 197 feet long and 82 feet wide—about two-thirds as long and one-half as wide as a football field. The distance from the bottom of its steel piles to the top of its derrick is 650 feet—equivalent to the height of a 50-story building. The platform is capable of drilling 12 directional wells. Upon their completion it can be turned into a giant production platform by removing the drilling equipment.

Its cost of more than $1,250,000, plus the price of $2,250,000 Shell paid the state of Louisiana for the lease, plus the expense of drilling, represents a total of more than $4,250,000 risked on the chance of finding oil at this particular spot.

Shell engineers decided a permanent type platform was the only practical means of drilling in the deep water and very soft, muddy sea bottom found in Block 42. The 53 steel piles on which it stands are 460 feet long. They sank 200 feet below the ocean floor before striking a "reaction" or resistive earth stratum and extend to a total depth of 370 feet into the mud. The main deck of the platform is 45 feet above the mean water level and the derrick towers another 160 feet above the deck.

The platform and derrick are designed to withstand the buffeting of 50 foot waves and 125 mile an hour winds.

An unusual feature of the platform is its movable superstructure which allows 12 wells to be drilled from the one location.

Below the drilling deck and about 10 feet above the water is a short steel deck having two rows of three "water table openings"—round holes through which the wells are drilled. Through these openings 500 feet of 30-inch drive pipe are sunk to keep out the sea water. The drill bit, drill stem and casing pass through these drive pipes.

Both the crown block at the top of the derrick and the rotary table on the 40 by 45 foot drilling deck can be shifted to a position over each of the water table openings. To drill six additional wells the entire drilling deck, derrick, draw works, engines, pipe racks and generators can be skidded some 22 feet along the platform.

The crew quarters have sleeping, galley, mess hall and recreation space for 30 men. Radio provides constant contact with Shell offices and the various craft serving the rig.

Three 450 horsepower diesel engines power the drawworks and three 75 kilowatt unit generators run the lights and air conditioning in the crew quarters. The racks hold 2100 tons of pipe. Tanks can store 2500 barrels of fresh water, 750 barrels of active mud and 1000 barrels of reserve mud. The rig also has space for 4000 sacks of dry mud and 1400 sacks of dry cement.

The platform was built in six sections, some of which weigh 250 tons, and was assembled on the Gulf location in 26 days.

1 The largest trailer-mounted drawworks and engines in the world. The trailer is 65½ feet long and 12⅔ feet wide, without the walkways. Total trailer weight is approximately 150,000 pounds. It has an idle bogey carriage with 24-inch by 18-inch sand tires. From the ground to the top of the sand reel measures approximately 16½ feet. Trailer dimensions and loads are considerably in excess of permissible road requirements in the U. S. Usual requirements state an 8-foot overall width with either 45 or 60-foot maximum trailer length.

The trailer is equipped with rotary table, rotary table drive, drawworks, hydromatic, engine compounds, three drilling engines and a stand-by fuel tank.

The drawworks is a double drum unit with a 49⅛-inch long by 22-inch diameter main drum, and a 12¾-inch diameter by 46¾-inch long sand real. Selective speed transmission provides six speeds forward and two reverse for drum or rotary drive.

There is pressure lubrication of all chain drives by dual pumps. All pressure grease fittings can be lubricated while drilling.

# World's Largest Mobile Rig

**A 10,000-foot, trailer-mounted rig designed for South American operations may point the way to greater compactness and mobility for drilling rigs in the United States.**

By JOHN N. SCHUELKE
World Oil Staff

Mene Grande Oil Company, Gulf Oil Company's South American subsidiary, has designed and assembled the largest mobile rig known to be in existence. The rig is designed for 10,000-foot drilling but may be used to 12,500 feet. This highly compact rig is designed and constructed so that it can be transported in four loads, exclusive of the drill pipe. The main load is the trailer-mounted drawworks and engines; the second load is the skid-mounted main pump with the auxiliary standby engine. A third load is made up of the substructure and derrick, while the fourth load is the light plant, standby pump, and miscellaneous equipment.

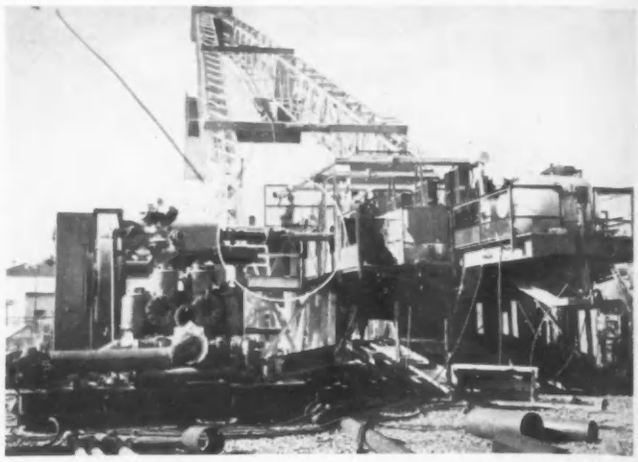
At the present time Mene Grande has 28 rigs in operation in Central Venezuela. All but three of these rigs are steam rigs. The designing of the large, mobile, power rig is an experiment to compare operational costs of the two types of rigs in their particular operations. This mobile rig will be put to work in Eastern Venezuela where the terrain is very similar to that found in West Texas.

Most of the equipment incorporated into this rig is of standard manufacture, but there are several innovations worthy of note. Primary among these is the torque tube drive of the main mud pump. This is a relatively new and possibly a cheaper method of pump drive. Second is the mounting of the auxiliary engine on the main pump skid. This provides standby power for the mud pump, or through the torque tube this power can be used for hoisting or table rotation in case of necessity.

The complete air operation of all the rig components should greatly simplify rig operation and give the driller instant control of all rig operations. Two small compressors, in addition to the compressor mounted on the compound, are provided to supply air for the blowout preventers, tong and slip operation, and for pressure lubrication of the rig.

A small air hoist is mounted on the derrick leg immediately behind the driller's station and will be used for most catheading operations, such as

**2** Aerial view of the machine shop yard where the large mobile rig was assembled gives some idea of the close working space available for the assembly job. The photo shows the 143-foot derrick in the assembled position prior to raising. All component parts of this rig were shipped to Houston for assembly and final testing. Special road permits from Oklahoma and Texas were needed in order to transport the trailer through these states.



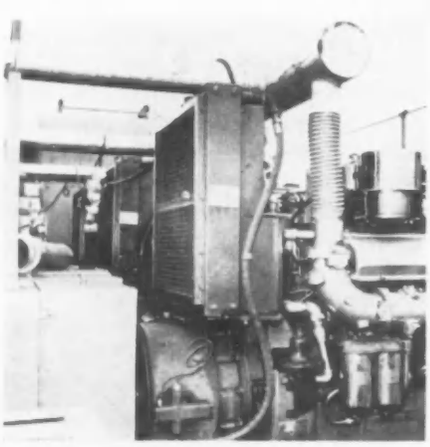
**3** The complete rig was assembled and tested in the yard in Houston. The above photo shows the rigidly trussed box-type, mast columns being erected. This derrick is a 143 trible and affords the derrick man and driller a clear view of all hoisting operations. Other component parts are being fitted into the compact highly mobile drilling rig. Note the torque tube pump drive from the engine compound to the pump skid (circled).

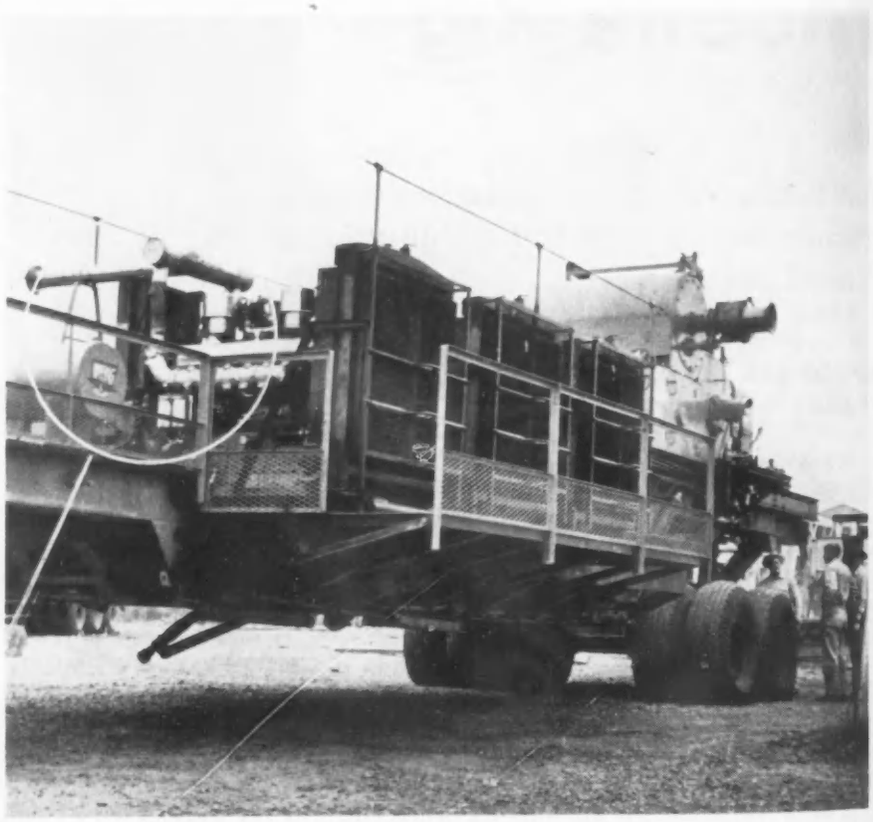
bringing pipe from the rack to the floor, etc. This position affords a better view of the floor to the catline operator.

Besides the main pump there is a second or standby pump, 7 inches by 14 inches, skid mounted, that will be used for mixing, compounding, or emergency circulating service.

Every possible means of making this rig compact has been used. The cooling water tank was built into the substructure. Suction, supercharging, and discharge lines were made an integral part of the pump skid. Flexible hoses were used wherever possible for rig piping to aid in fast coupling and uncoupling, as well as ease of transportation. Most of the walkways are hinged and fold out of the way for quick moves. All major operational pieces of equipment have standby or bypass provisions where malfunctions or failures will not necessitate a shutdown of operations.

As can be noticed in the accompanying photos there is a great variety of manufacturers represented on this rig. That so many varied pieces of equipment could be brought together and assembled into one highly compact, mobile rig is a tribute to the growing emphasis on standardization and interchangeability of the component parts for the modern drilling rig. The operational success or failure of this rig in South America will be watched by the drilling industry with interest, as the demand for powerful, compact mobile rigs is ever increasing.





**4** Three 12-cylinder industrial engines with dual carburetion are mounted on the same trailer with the draw works. Each of these engines has a 350-continuous horsepower rating, and can operate on either natural gas or butane. Butane will be used in the South American drilling because of availability and economy. This dual carburetion system has an efficiency advantage of 15 to 20 percent over a converted carburetion system.

At the left is a view of the torque converters and the heat exchangers for the torque converter fluid and the engine oil.

*More pictures on Page 120*

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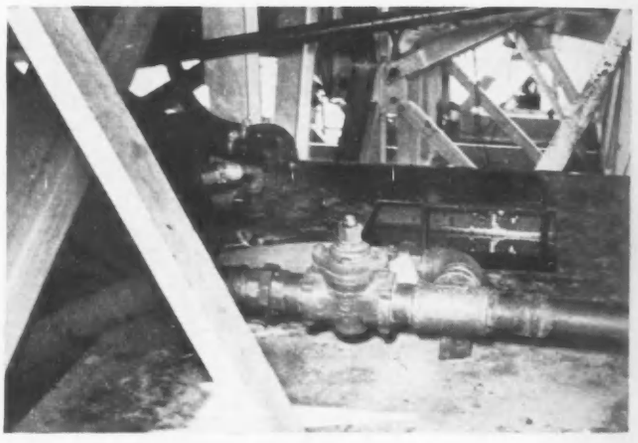
**5** The substructure is of standard manufacture and is U-shaped to permit the draw works trailer with mounted rotary table to be backed into the U. The trailer is held tightly in place by turnbuckles fastened to the substructure. Note the ramp that correctly positions the trailer height with respect to the derrick floor. In the substructure at the right can be seen the cooling water tank. Mounted on the right side of the substructure is the bracket for the wire rope spool.

**6** The wire rope spool is supported in brackets that can be easily unbolted and removed when the rig is being moved. Note the dead line going under the substructure to the dead line clamp at the base of the derrick leg. With the spool up off the ground and free to unspool, the cutting off of the drilling line is simplified and a great amount of time and labor is saved.

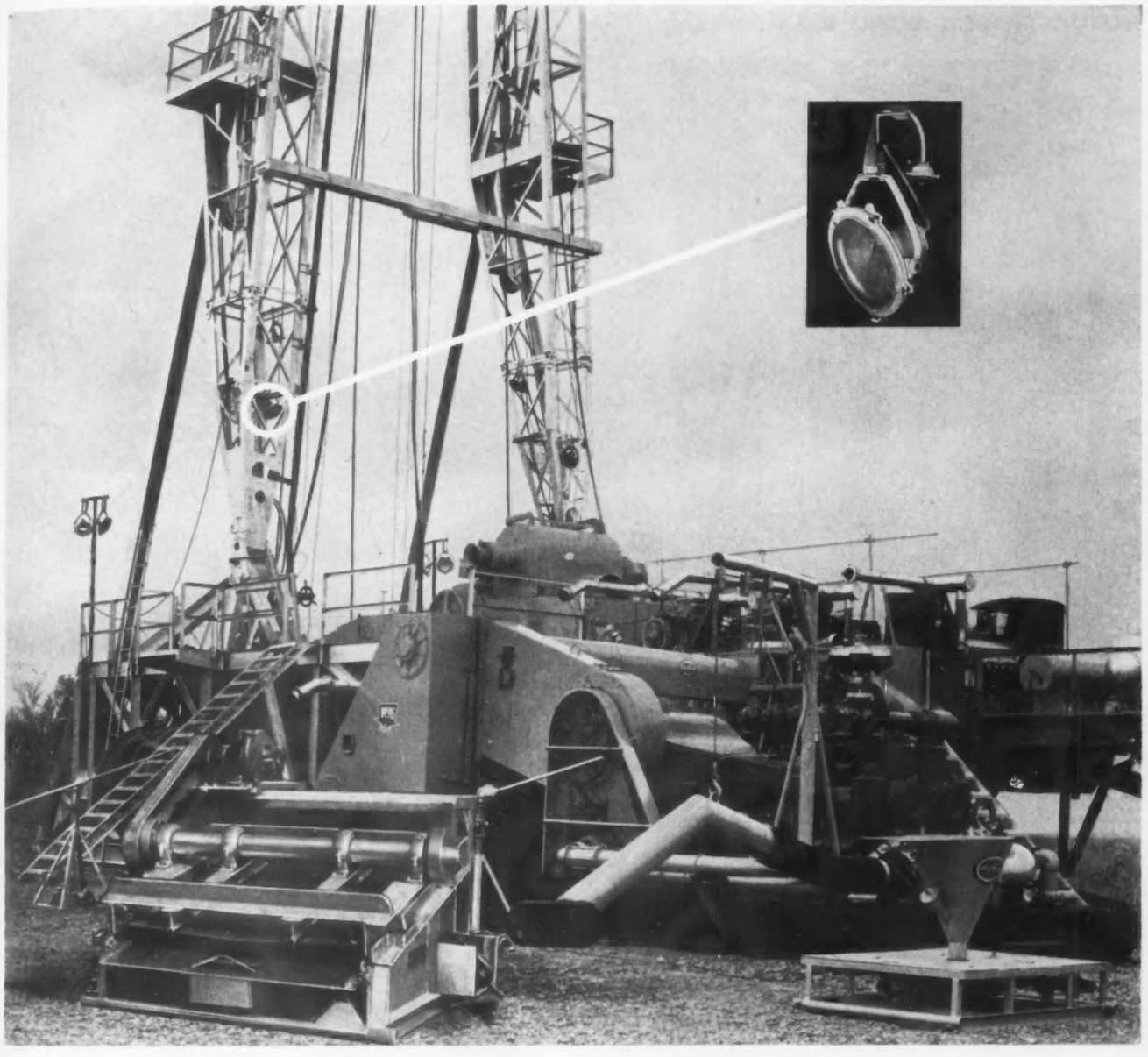


**7** Top of the water tank that is built into the substructure. A small rotary pump circulates water through the brake drums, the hydromatic, and into the cooling tank. A small electrically driven pump, mounted under the flooring on the back side of the No. 3 engine, is a stand-by pump in case of failure.

A float control mounted in the water tank will keep water level constant and approximately one foot from top of the tank. This assures a ready supply of 1500 gallons of water for cooling the brakes and hydromatic.

**8** These are the men who had a part in the assembling of the world's largest mobile rig. From left to right they are: Jake Tips, engineer, Joe Stine, Inc.; Clyde Bloss, service engineer, Ideco; Carl Bates, J & L Supply; Joe Stine, owner Joe Stine, Inc.; Horace Branham, chief service engineer, Ideco; Tom Crain, Harvey Tool Company; George Saunders, Mene Grande; Ed Arnold, Mene Grande; E. T. Markham, Jr., Mene Grande; Jack Weems, Mid-Continent Supply; and Bill Sullivan, Unitrig.

*More pictures on Page 122*



# For the World's Largest Portable Rig

## *HUTCHISON—the World's Most Dependable Equipment*

Equipment has to be dependable when a drilling rig is operating in an isolated and inaccessible area. That's why HUTCHISON "Flolight" vapor proof lighting sets were used exclusively on the world's largest portable drilling rig located in Venezuela. "Flolights" are built to take it—rig light belt hangers absorb derrick vibrations and cushion shock on "Flolights" not only during drilling operations, but when the rig is moved from place to place. "Flolights" are easily adjusted to each drilling operation, but stay in place once the position is determined for best lighting. They're vapor proof, built to operate efficiently in any climate.

That's why the HUTCHISON "Rhumba" Shale Shaker with built-in De-Sander was also selected for the world's largest portable rig. The "Rhumba" Shale Shaker and De-Sander excell in performance and low cost maintenance. An underslung screen cloth, with no obstructions on the bottom removes sand by a new method of flotation—reducing wear and maintenance on pumps. The "Rhumba" Shale Shaker and De-Sander has fewer exposed parts, is of rugged construction, is fully portable as the rig—features which save on maintenance and replacement costs. In out of the way places, dependability is important. HUTCHISON dependability is part of the world's largest portable rig.

## HUTCHISON MANUFACTURING COMPANY

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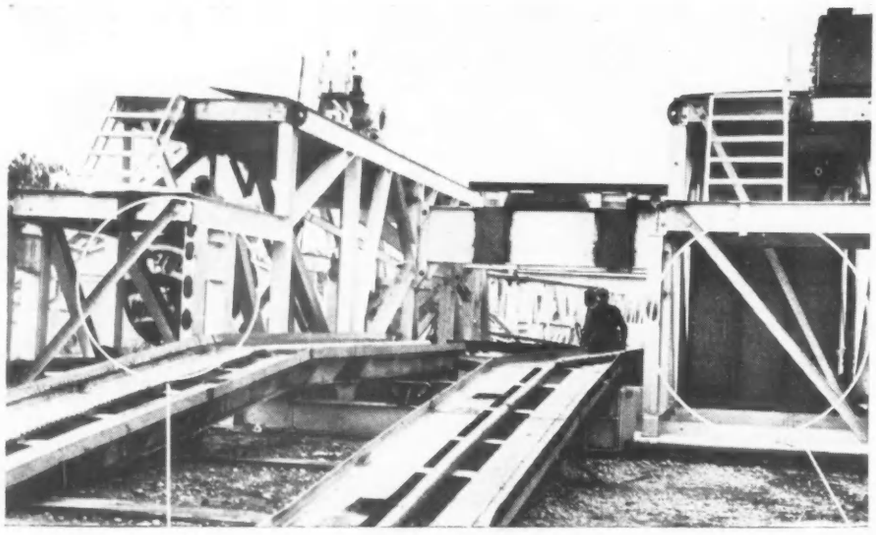

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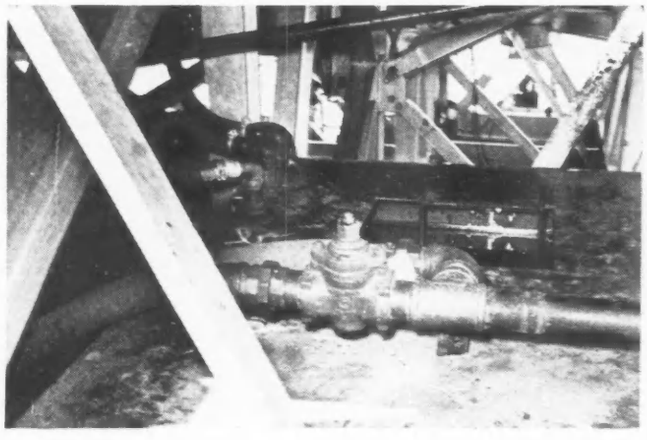

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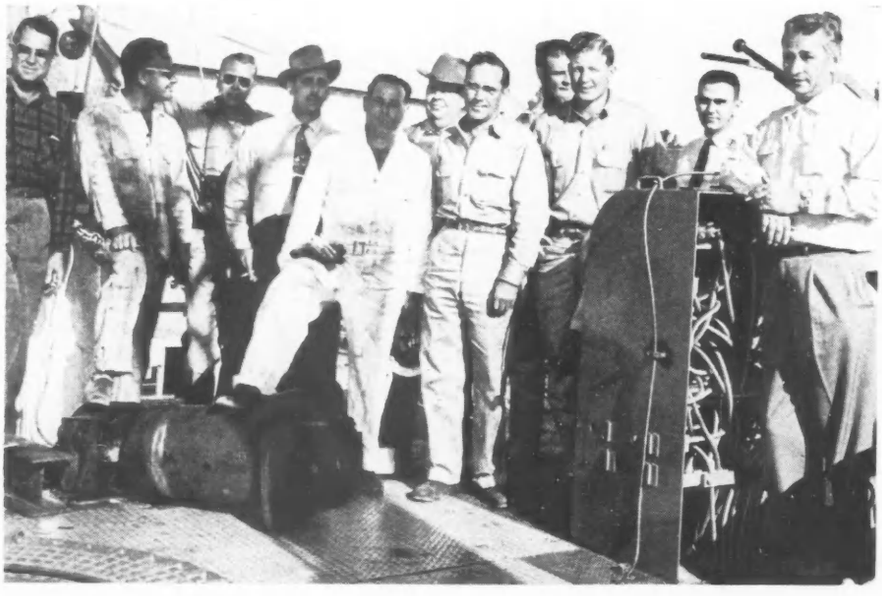

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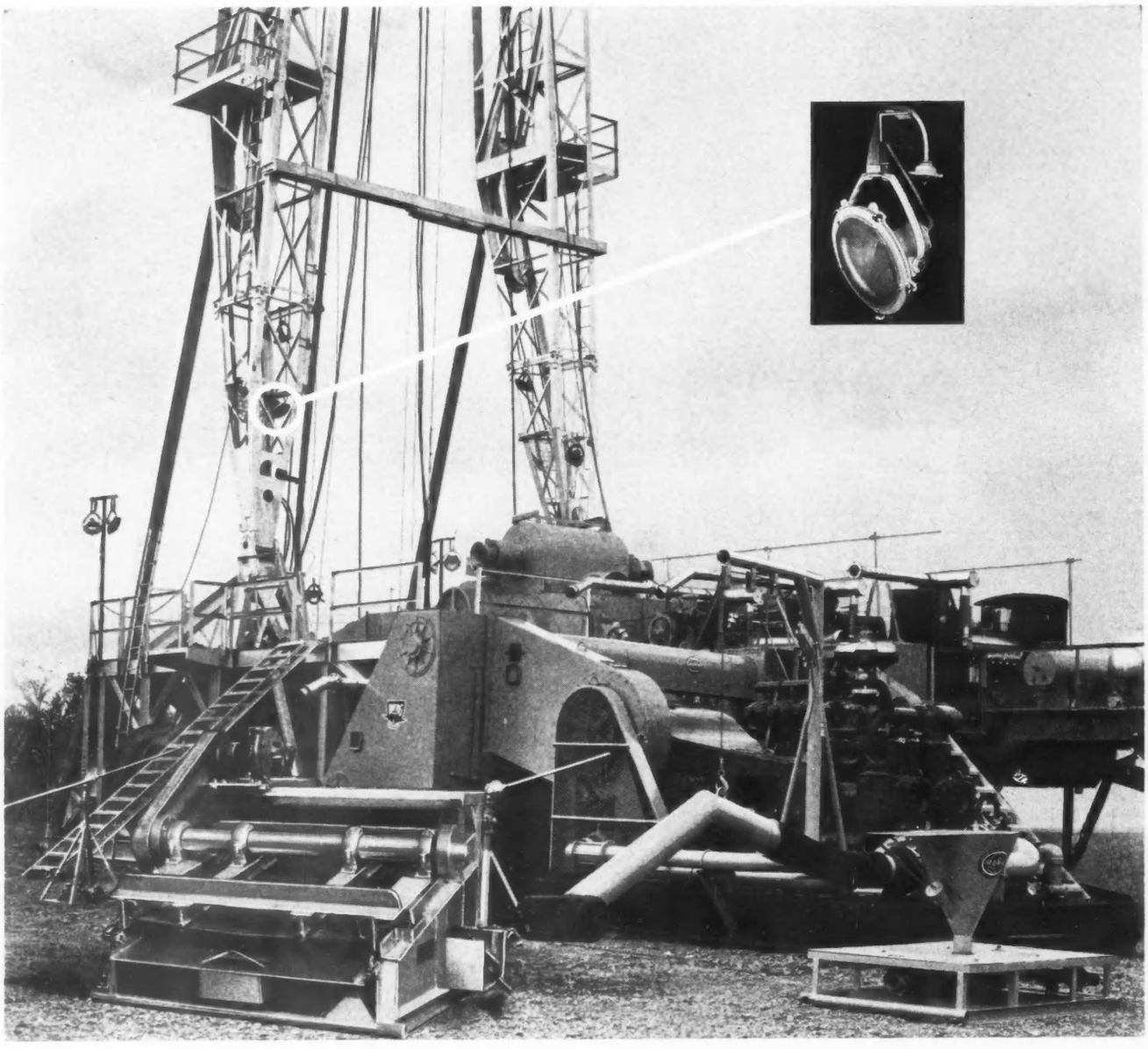
*More pictures on Page 122*



# For the World's Largest Portable Rig

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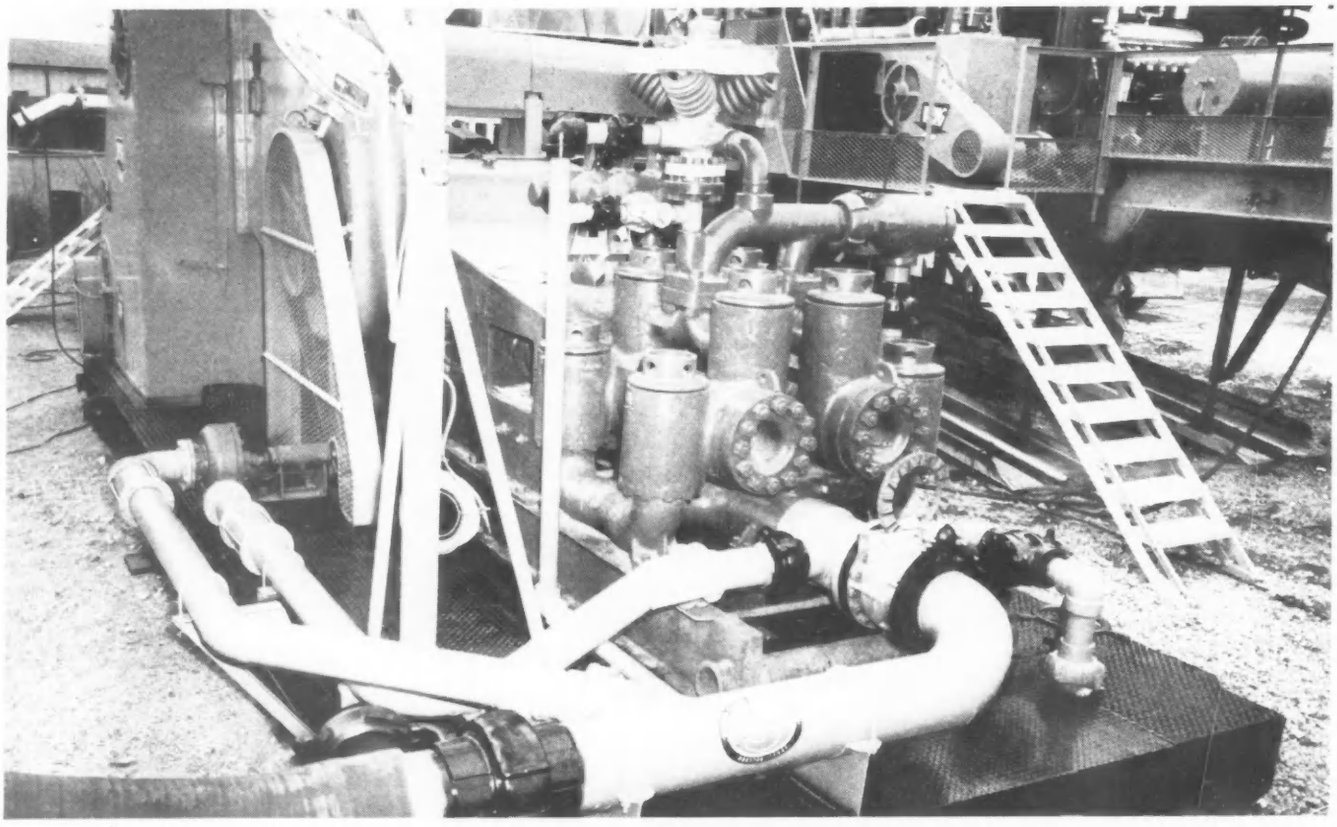
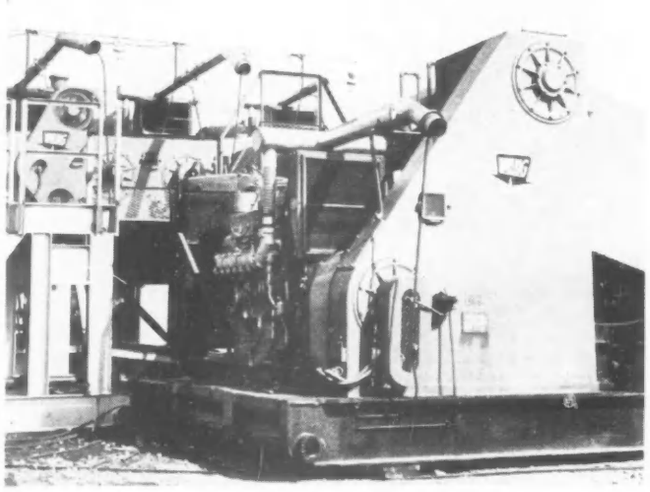
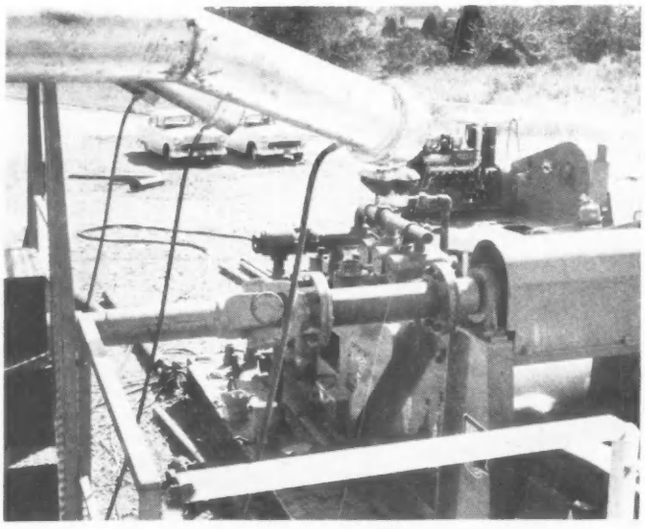


**9** The main mud pump skid is 12 feet wide and 25 feet long. The assembled pump and auxiliary engine weighs approximately 100,000 pounds. The 18-inch pump has a maximum capacity of 933 gpm at 1328 psi with 8¼-inch liners. Maximum output is 722-hp at 60 rpm. Instead of the usual in-line belt or chain drive, this pump is driven from the main compound by a torque tube. The tube is designed to transmit 1200-hp and chain drives the pump through a compound with a splined clutch. An auxiliary engine, mounted on the pump skid, is same size and rating as the three engines in the main power unit. It can be used to drive the pump in case of main engine failure, and also can supply power through the torque tube and compound for hoisting, or for table rotation in an emergency. The torque drive is nine feet from ground level.

A unique feature is the small rotary pump, mounted on the skid, used to supercharge the pump suction. It has an intake from the main suction line and delivers mud under a slight head to the pump suction behind the blind, which is closed during operation of the rotary pump. It is belt driven from the pinion shaft of the mud pump and can be shut down by closing the quick opening valves and opening the blind.



**10** Auxiliary engine and pump compound on rear of main pump skid. Through this unique pump drive set-up, torque tube transmits power through a chain drive to the pump. A spline clutch, air controlled from the driller's console, is used at this point to disconnect the torque tube, or the pump, as the case may be. The engine is equipped with a torque converter. An air clutch engages or disengages the engine. The air clutch on the pump compound is used if it becomes necessary to drive the pump with the auxiliary engine, or to disengage the pump and use the auxiliary engine for table rotation or hoisting.



**11** A general view of the torque tube and main mud pump taken from the rotary side of the draw works. The torque tube extends from the power take-off of the compound through the outrigger saddle bearing to the pump compound. Two universal joints are employed in this tube (one is under the walkway to the left) so that the pump will not have to be in exact alignment with the compound.

*More pictures on Page 124*

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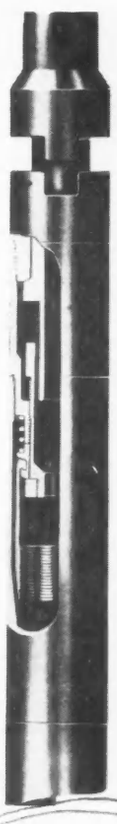

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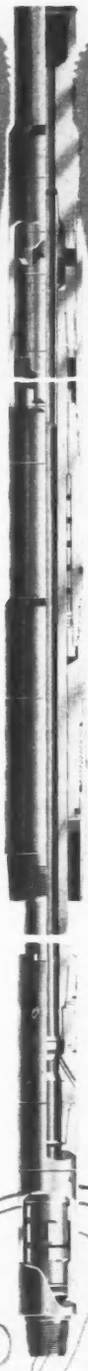

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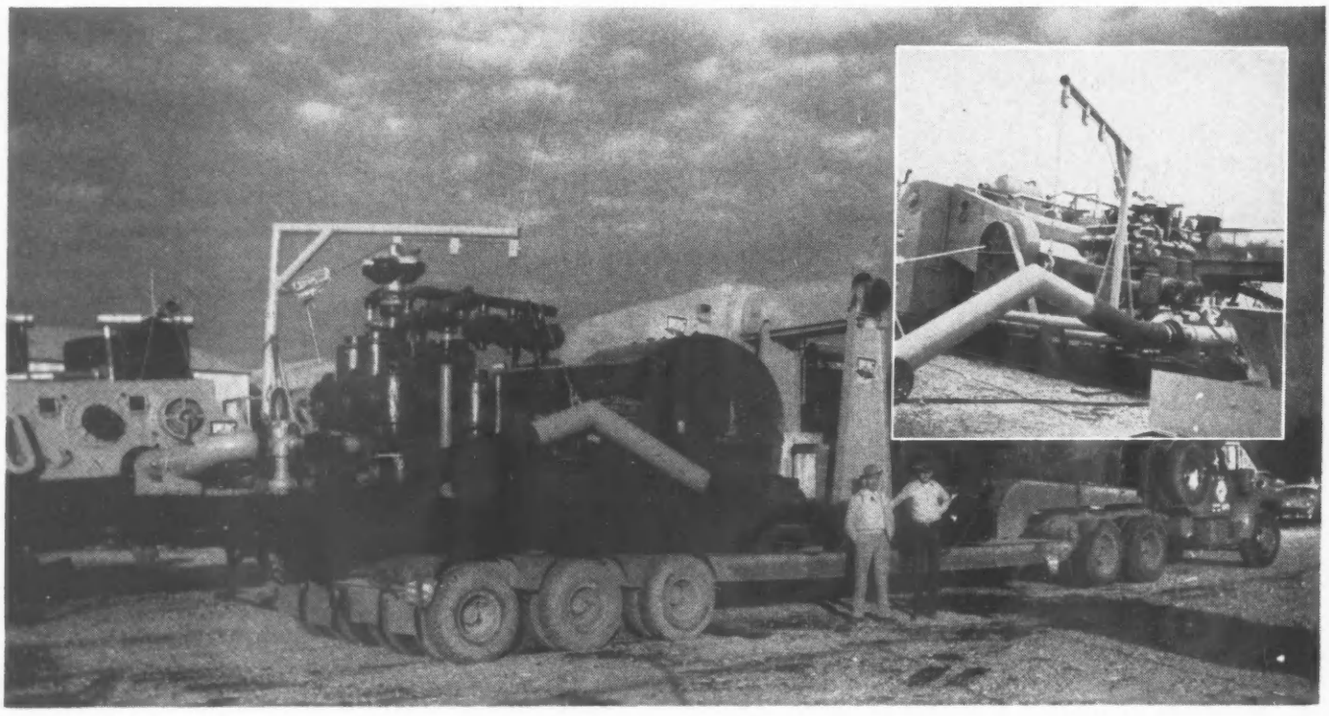
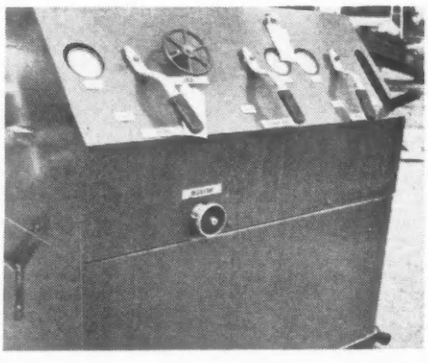


**12** The main pump skid, mounted on a low boy, is ready for the road. Note compactness of pump lines, pulsation dampeners, strainers, safety valve and utility hoist. The torque tube flange is noticeable on the saddle bearing mount between pump and auxiliary engine.

Inset shows utility hoist in position for raising or lowering height of mud pump suction. Note three sets of sheaves on the cross arm. To service valves or liners on this pump, the mud hose is lowered and the hoist is disconnected. Hoisting line is then placed over the proper sheave and is used to aid in removing valve pot lids or liner covers, thus preventing smashed fingers.

**13** A general view of the three-engine compound. A shaft extension from the No. 1 engine drives the small air compressor to supply air for clutch operation. The shaft extension from the No. 3 engine is used to drive the small water circulating pump. Master clutch has locking pins for positive drive.



**14** The blow-out preventer console that will be mounted on the derrick floor right behind the driller's station is equipped for closing two sets of conventional rams and one full closing hydraulic blow-out preventer.

*More pictures on Page 126*

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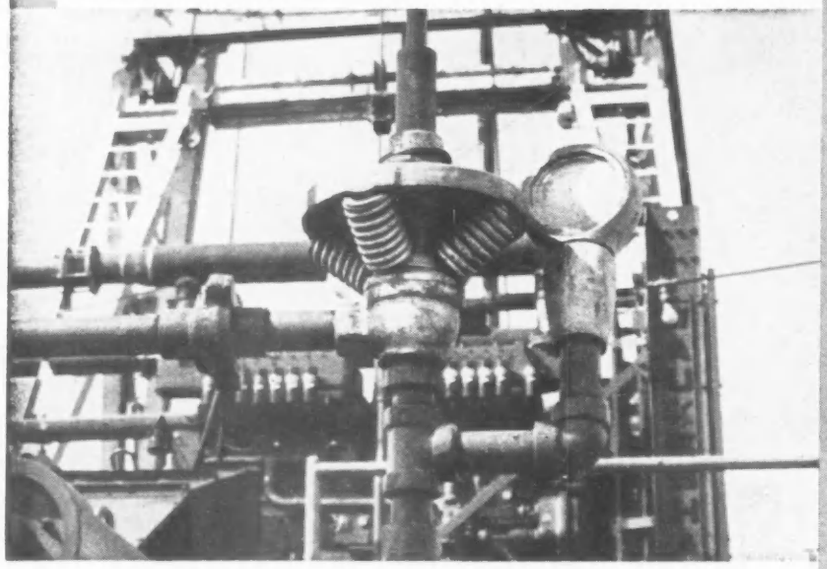

When overloads occur, the Kinzbach Model 112 Valve relieves the system instantly of the overload surge. Line pressure is maintained at a pre-set level, thus reducing the danger of a blowout. And, in case of momentary blockage, circulation is restored immediately, eliminating the danger of suspended cuttings settling and causing stuck pipe.

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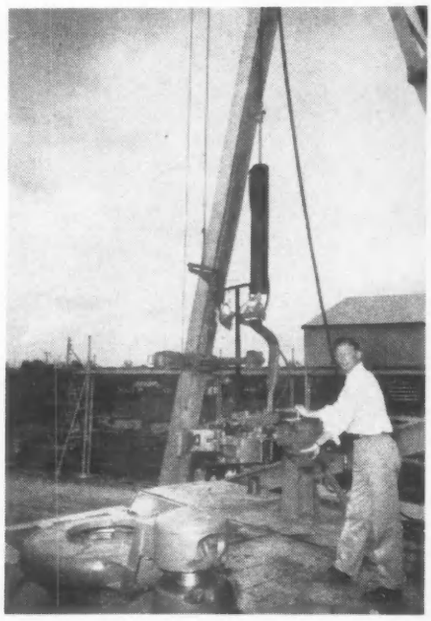
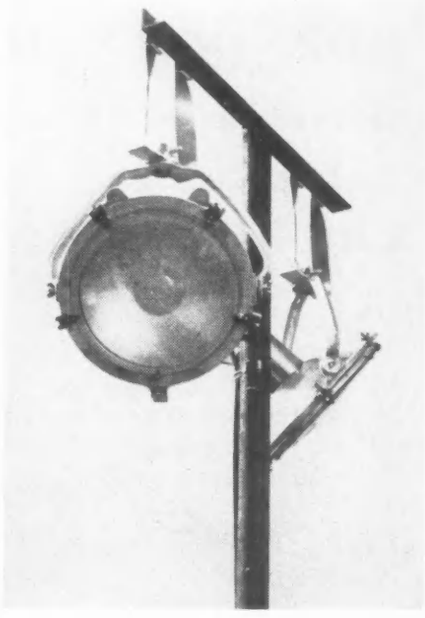
*(Continued)*



**15** Modern, labor saving air slips and tongs are provided on this rig as well as the standby manual tongs shown hanging above and behind the air slips. E. T. Markham, Jr., tool pusher for Mene Grande, is shown with his hand on the spinning control of the air tongs.



**16** Flood lights for the rig floor are suspended from fiber hangers so that rig vibrations will not be transmitted to the light sockets or bulbs. This method of mounting should cut down considerably on the number of light bulbs and sockets that must be replaced. Other flood lights are suspended in a similar manner from derrick trusses.

—The End

IG

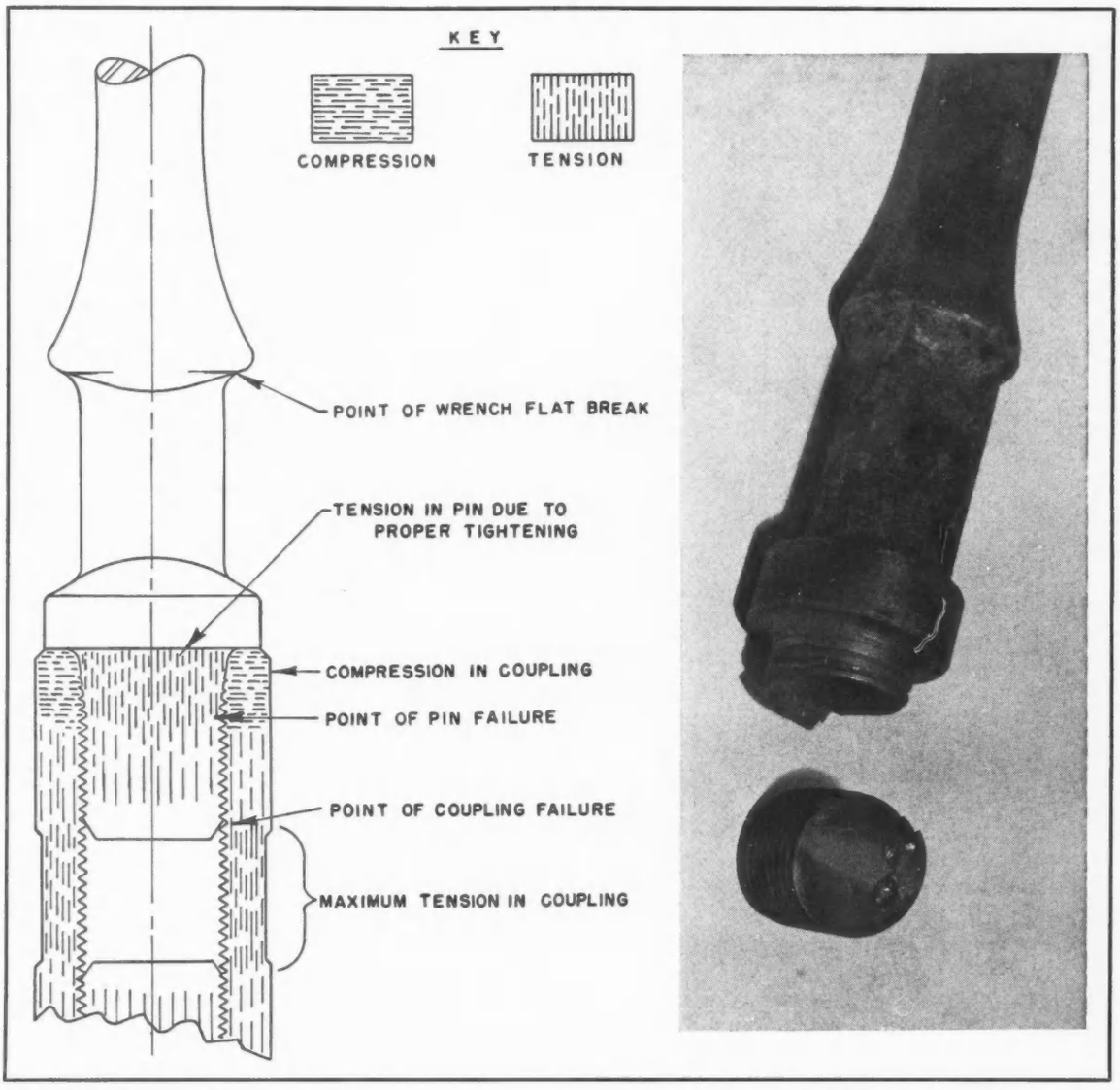



FIGURE 1—Where sucker rod pin failures occur.



FIGURE 2—A broken pin.

# What to Do About Sucker Rod Failures

## Do you know just how tight is "tight enough" for sucker rod joints?

**By A. A. HARDY,** Chief Engineer, W. C. Norris Manufacturing Co., Tulsa

PRACTICALLY all sucker rod pin failures are due to fatigue and invariably occur at the last full thread, as shown by the arrow in Figure 1. A picture of a broken pin is shown in Figure 2. The break is always at right angles to the axis of the pin and is smooth and stained in a half moon where the break started and rough and ragged 180 degree from the start where the final rupture occurred. The significant fact about fatigue breaks is that they are caused by a high range of stress variation over thousands or even hundreds of thousands of stress cycles and not by high stress alone. No piece of steel has ever been broken by a single high stress even beyond its elastic limit so long as the stress has not exceeded its ultimate strength.

These failures, then, being caused by fatigue must be due to a high range of stress variation. This high range of stress can only occur when the faces separate under load. The faces can only separate when the tension in the pin due to tightening is less than the tension induced due to the working load; or, in terms of the analogue shown in Figure 3, when the tension in spring "B" is less than the load applied to the hook.

The remedy, then, obviously is to tighten the joints initially so that the faces do not separate when the working load is applied. This requirement has been pointed out by several authors, such as Mills,[1] Doughtie and Carter,[2] Sauer, Lemmon, and Lynn,[3] Almen,[4] and many others. To do this, a predetermined torque must be carefully applied to the joints as they are run. Doughtie and Carter have sug-

gested a formula showing the relationship between torque and pin stress which appears to work out very well for sucker-rod joints.

$$T = \frac{F}{2}\left(\frac{p}{\pi} + \frac{Ef}{\cos_\alpha} + D_c f_c\right)$$

wherein:

T = Torque required to turn the coupling, lv-in.
F = Axial tensil load in pin, lb.
p = Pitch of threads, in.
E = Pitch diameter of screw thread, in.
f = Coefficient of friction between threads.
$f_c$ = Coefficient of friction between contact faces.
$D_c$ = Mean diameter of contact faces.
$\alpha$ = One-half the included thread angle measured in a plane through the bolt axis.
= 30 degrees.

Experiments by the writer and a study of similar experiments by others has indicated that the coefficients of friction in this formula should be evaluated at 0.11. This may seem low for the average threaded joint, but the API sucker rod joint is not an average commercial joint. The API tolerances make it considerably above average in quality resulting in good finish and lower than average friction.

Assuming that the stress desired in the pin is 40,000 pounds per square inch and solving for the torque required for this condition, we have the following results:

⅝-inch Rods—213 foot/pounds
¾-inch Rods—340 foot/pounds
⅞-inch Rods—512 foot/pounds
1-inch Rods—770 foot/pounds

In terms of weight or force required at the end of a three foot arm, this would be:

⅝-inch Rods— 71 pounds
¾-inch Rods—113 pounds
⅞-inch Rods—171 pounds
1-inch Rods—257 pounds

Experience has been that an impact wrench, as ordinarily used, will build up between 200 and 500 foot/pounds of torque, depending on how it is used. If this be true, we should, assuming that the above figures are correct, very seldom experience any breaks in ⅝-inch pins and occasionally experience breaks in ¾-inch pins; ⅞-inch and 1-inch pins should be the most common type of break. This is actually borne out in experience. We never hear of broken ⅝-inch pins. Occasionally, we have a few ¾-inch broken pins. Most of our pin breaks occur in ⅞-inch rods, with a few 1-inch. However, the number of 1-inch rods in operation is far less than the number of ⅞-inch and would explain this discrepancy.

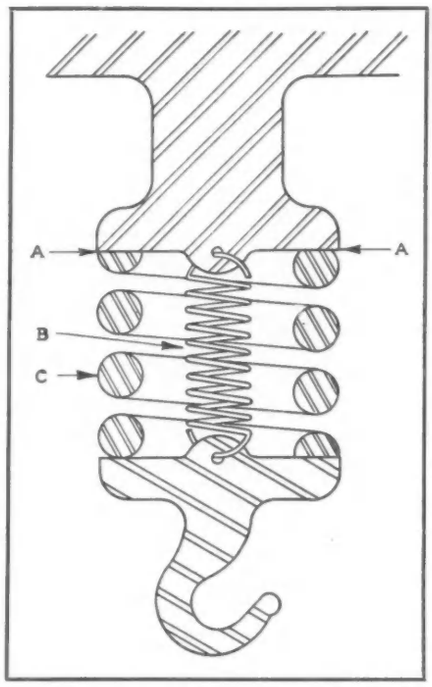



**FIGURE 3—Double spring analogue.**

It is believed that we should throw away all of our impact wrenches and use one of the commercially available torque wrenches, air-powered sucker rod wrenches set for the proper torque, or give the men two or three-foot cheaters, depending on the rod size, and school them in tightening in the proper manner. The impact wrench method, at the best is highly uncontrollable and highly unpredictable.

In the above instances 40,000 pounds per square inch has been selected arbitrarily as the desired stress to be generated in the pin by proper tightening. As can be seen by a study of the spring analogue in Figure 3, ideally, a load on the contact faces slightly in excess of the maximum working load on the string would prevent the faces from separating and should be sufficient. On the other hand, the limiting factor in tightening too much is the danger of stretching the pin appreciably beyond the yield point. In attempting to load the contact faces just above the maximum working load, we have several variables with which to contend: The actual maximum working load itself, the tightening torque results which vary with friction of the joint threads, friction of the contact faces, amount of lubricant in the joint, or lack of it and the accuracy of the torque load actually applied. We need a load then sufficiently high to offset these variables in all cases.

As far as tightening too much is concerned, approaching or even reaching the yield point is not necessarily objectionable. D. R. Miller,[5] of the National Bureau of Standards, has pointed out that even if the elastic limit of the pin is exceeded in tightening, no particular harm is done. Actually, exceeding it slightly may be beneficial. One recognized means of improving the fatigue life of steel is to stretch it beyond its elastic limit. This fact has been pointed out by Almen[6] with reference to cut threads on studs and bolts, who also subscribes to torquing threaded connections beyond the yield point where the application is of the same nature as the sucker rod joint. Such action stretches the metal at the root of the thread beyond the yield point leaving it in compression when the stress is reduced. Metal in compression cannot fail in fatigue. Thus 40,000 psi has been chosen as having a reasonable margin of safety above face separation yet low enough so that the pin will not be stretched dangerously beyond its yield point in extreme instances. Thus it becomes evident that the danger, as far as pin failure is concerned, is far less in applying too much torque than in applying too little.

The above reasoning is based on the premise that thread surfaces are smooth, clean and of good form, all resulting in an easy running joint with a low coefficient of friction, as mentioned above. If dirt or foreign matter is introduced into the joint the coefficient of friction mounts very rapidly and invalidates the above figures quite radically as can be seen from an inspection of the above formula. For instance, in the case of the ⅞-inch joint, to which 512 feet pounds torque should be applied, using the above formula, a 0.22 coefficient of friction and the same torque, the resulting load and stress in the pin would be cut about in half, well below the maximum recommended rod body load. With this condition the joint faces would separate and the pin would soon fail. In practice this means that even a small amount of dirt in the rod joint can very easily result in a broken pin.

Of course, it is conceivable and highly possible that a joint may loosen in service even though properly tightened. This possibility can only be

overcome in the present joint by increasing the friction which resists loosening such as by removing all grease on the contact faces of the pin shoulder and coupling, being careful to leave it on the threads of both pin and coupling. The writer realizes that this is a "large order" in actual practice.

## Is Thread Design The Answer?

The obvious alternative to close scrutiny by field personnel appears to lie in a reconsideration of sucker rod thread design.

The present standard API sucker rod joint was originally adopted by API in November 1926. Minor changes have been made from time to time, but it is basically the same now as it was when first adopted. It has done and is doing an excellent job and has saved the industry many millions of dollars which would have been lost if no standard had been set or a poor design had been standardized.

The joint is not perfect, however, and broken pins frequently occur. While most of the causes of failure lie in improper handling, another design, less susceptible to being mishandled and not so vulnerable to failure would be of great value to the industry. As it has been more than a quarter of a century since the present design was adopted, it is high time, particularly in view of our added screw thread design experience and advanced knowledge of metallurgy and fatigue, that we investigate the causes of our present troubles and use this knowledge upon which to design a better, more trouble-free sucker rod joint.

Great advances have been made during the past eight or ten years in screw thread design and investigation. In November 1948, culminating many years of intensive study and research, the U. S., together with the United Kingdom and the Dominion of Canada, jointly signed the "Declaration of Accord," which covered a new unified standard for screw threads. The American Standards Association immediately revised their then existing standard and in 1949, published ASA B1.1-1949 titled "Unified and American Screw Threads." This was followed in March, 1951, with the "1950 Supplement to Screw Thread Standards for Federal Services," issued by the National Bureau of Standards of the United States Department of Commerce, which also conformed to the new "Unified" screw thread standard. Since that time, industry, generally, in the U. S. has progressed a long way in the change over to the new thread.

For many years, thread experts have maintained that the class of thread, that is the fit, which specifies tolerances and allowances, for the API sucker rod connection, was much closer than necessary or desirable. It has been felt by the trade, however, that a close fit requiring precision tools and gages would result in a stronger and more satisfactory joint. This was logical thinking, but in view of the recent advancement in the screw thread art, it behooves us to take a second and closer look at the problem. We might have a great deal to gain.

Under the old standards there were five classes of threads roughly cataloged as follows:

- Class 1: Ready interchangeability, with loose fits and maximum tolerances.
- Class 2: Good interchangeability, reasonable fits and tolerances. This class covers the major portion of interchangeable screw thread work in all industries.
- Class 3: Highest grade of interchangeability with close fits and minimum tolerances for a production product.
- Class 4: Interchangeability not 100 percent, may be selective with close fits and little tolerance, a precision product requiring expensive special gages and gaging practice.
- Class 5: An interference fit requiring use of wrench for make up. Ordinarily made up only once, such as steel studs in engine blocks.
- Class 4 and Class 5 have now been abandoned.

The API sucker rod joint does not conform to any of the above enumerated standards but falls between a Class 3 and Class 4 fit and consequently becomes a precision product. If the closeness of fit and precise quality of the thread were to be indicative of the strength of the joint and the service to be expected from it, the care and expense required to obtain it might well be worth the trouble. Recent studies have proved this not to be true.

Prof. Buckingham of the Massachusetts Institute of Technology has conducted an extensive series of tests to obtain information about the influence of the class of fit on the tensile strength of general purpose bolts and nuts. In this interesting bit of research work, several sizes of bolts and nuts made from several grades of steel were tested in lots, each lot, of course, being the same material and consisting of about 25 samples each of Class 1, Class 2 and Class 3.

Professor Buckingham concludes with: ". . . the class of fit is of little or no importance. Any additional time, effort, or money which is expended on the making of these threaded bolts and nuts of ductile materials (steel) with tolerances more exacting than those of Class 1 is an unnecessary waste." He then presents a mass of data which clearly indicates that in tension the Class 1 thread is just as strong as the Class 2 or Class 3 thread. Nothing is gained strengthwise as far as tensile strength is concerned by going to more precise fits. Thus, surprising as it may seem, our sucker rod Class 3 to 4 thread fit adds nothing to the strength in tension of the joint over that to be obtained from Class 1 or a Class 2 fit. But sucker rod pins fail in fatigue, not tension. How does class of fit affect this type of failure? The closer fit promotes fatigue failure.

It is universally acknowledged that pin failure due to fatigue (99 percent of such failures) is due to lack of, or loss of, proper initial tightening, which will generate high face pressures at the shoulders and a consequent low range of stress, under load, in the pin. A close fit will militate against proper face and shoulder pressure on several counts.

A close fit adds friction to make up and absorbs torque which would otherwise have been used in generating proper face pressure. In the spring of last year, the author worked with others on a test string in a well in West Texas. It was a mixed string of tight fits and free running fits alternated from top to bottom. In seven weeks five pin failures were experienced in the tight fit pins, with none in the free running fit pins. The test was then discontinued.

A close fit requires precise parallelism of shoulder faces to avoid high

local stresses on one side of the pin, while a looser fit will mechanically accommodate a small amount of misalignment without the high local stresses. Quoting from Page 95 of the Federal Service 1950 Supplement to screw thread standards: "A close fitting thread assembly under some conditions may fail whereas the cause of failure may be eliminated by providing a looser fit. A cap screw that seats only on one side of the bearing surface under the head may break off when the screw is tightened. When a screw has a large bearing surface under the head or when the head must be square with a projecting pin, sufficient pitch diameter clearance must be provided to allow for any out-of-squareness of the screw axis with the bearing surface under the head. Thus, as large a pitch diameter tolerance as possible, together with providing proper tolerances on squareness of face with the thread axis where seating is required may avoid the necessity for specifying a heat treated bolt."

A close fit will provide little if any clearance for foreign matter and must be kept meticulously clean if high friction and its attendant troubles are to be avoided. The conditions under which sucker rods are run and rerun in particular, are far from conducive to this requirement. A looser fit would tolerate more dirt and sand and would avoid many broken pins on this count alone.

A close fit, liberally greased, can and does build up substantial hydraulic resistance to tightening and will thus absorb torque at the expense of proper shoulder and face pressure. This has been dramatically demonstrated in the author's plant. A looser fit would prevent this undesirable condition.

A close fit requires a precision in thread form and lead approaching that required for gages which in a production operation as in the existing sucker rod thread, is difficult to obtain and uneconomical. A looser fit would overcome this difficulty with no sacrifice in quality of performance.

When the tightness of fit is excessive, the couplings are hammered by field operators and many are broken or damaged by this hammering.

Quoting from a letter written by C. E. Haven of the National Bureau of Standards, U. S. Department of Commerce and also a member of the API Correlating Committee on gages: "I am in complete accord with the belief that sucker rod threads should be made to Class 2A-2B tolerances and that most of the failures in joints are due to insufficient tightening of the threaded connections."

The thought should be stressed that improvement in the performance of the sucker rod joint should be and is our sole aim. Our increased knowledge and experience of the past few years now clearly demonstrates that a Class 2A-2B fit in accordance with the new "Unified Standards" is not only as strong but is much preferred from a performance standpoint to our present antiquated Class 3½ sucker rod thread. The thought should also be stressed that such an adoption would not open the gates to sloppy work. The new fit would be just as closely controlled with just as precise gages and gaging practice as we now use.

Also the old and the new would have 100 percent interchangeability. The only effect would be a median compromise with one member of the joint the old standard and one the new; hence such a condition would be more desirable than the old.

Table 1 gives the dimensions which would result from the application of the "Unified" Class 2A-2B standard to the sucker rod thread. It is strongly urged that the API seriously consider and adopt the Class 2A-2B thread dimensions for the sucker rod joint standard.

## About the Author

A. A. HARDY was graduated from the University of Wisconsin with a degree in civil engineering. He worked for the Prairie Pipeline Company at Tulsa in the Mechanical Engineering department. As a result of the merger of Prairie and Sinclair, he was transferred to the Purchasing department of the Sinclair companies as engineering buyer for mechanical equipment. From 1942 to 1944 he was with the War Production Board as priorities manager for eastern Oklahoma. He then became chief engineer and works manager for the American Manufacturing Company at Fort Worth. Since 1946 Mr. Hardy has been chief engineer for W. C. Norris, Manufacturer, Inc.

**TABLE 1**

**Sucker Rod Threads—Class 2A-B—10 Thread**

| | | 5/8 (15/16) | 3/4 (1 1/16) | 7/8 (1 3/16) | 1 (1 3/8) | 1 1/8 (1 9/16) |
|---|---|---|---|---|---|---|
| | | .001468 | .001531 | .001588 | .001668 | .001741 |
| | | .001591 | .001759 | .001759 | .001984 | .002121 |
| | | .003232 | .003232 | .003232 | .003232 | .003232 |
| External P.D. Tolerance | | .006291 | .006522 | .006579 | .006884 | .007094 |
| Allowance | | .00189 | .00196 | .00197 | .00207 | .00213 |
| Internal P.D. Tolerance | | .00818 | .00848 | .00855 | .00895 | .00922 |
| PIN | Max. Major | .93561 | 1.06054 | 1.18553 | 1.37293 | 1.5603 |
| | Min. Major | .92268 | 1.04761 | 1.17260 | 1.36000 | 1.54744 |
| | Max. Pitch | .87066 | .99559 | 1.12058 | 1.30798 | 1.49542 |
| | Min. Pitch | .86437 | .98907 | 1.11400 | 1.30110 | 1.48833 |
| | Max. Minor | .81293 | .93786 | 1.06285 | 1.25025 | 1.43769 |
| COUPLING | Min. Major | .93750 | 1.06250 | 1.18750 | 1.37500 | 1.56250 |
| | Min. Pitch | .87255 | .99755 | 1.12255 | 1.31005 | 1.49755 |
| | Max. Pitch | .88073 | 1.00603 | 1.13110 | 1.31900 | 1.50677 |
| | Min. Minor | .82924 | .95424 | 1.07924 | 1.26674 | 1.45424 |
| | Max. Minor | .85024 | .97524 | 1.10024 | 1.28774 | 1.47524 |

$$\text{Major Diameter Tolerance} = .06\sqrt[3]{0.1^2} = .01293$$

$h_b = .06495$

$h_s = .06134$

$h_n = .05413$

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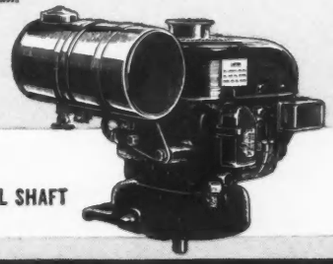

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Practical field problems may be solved without involved calculations by . . .

# Applying Van Everdingen and Hurst Solutions to Natural Gas Flow Problems

**By DAVID CORNELL,** Monsanto Chemical Company, Dayton, Ohio

PRESENT-DAY THEORY and actual well test data both show that in many commercially important natural gas reservoirs, unsteady state flow must be considered in calculating well behavior. The mathematical theory behind such calculations, while simple in principle, is too involved for routine field calculations. However, it is possible to apply the final results of such derivations to practical field problems without becoming concerned with the involved calculations necessary for obtaining the final results. This paper will show how the unsteady state flow solutions of Van Everdingen and Hurst[1] may be applied to natural gas reservoir problems.

**Theory.** The basic equation for radial flow towards a producing gas well or away from an injection gas well, considering unsteady state, is given by Equation 1.

$$\frac{\partial (p^2)}{\partial \theta} = \frac{(4.39)\ (10^{-6})\ (K)\ (p)}{(\mu)\ (\phi)} \left[ \frac{\partial^2 (p^2)}{\partial r^2} + \frac{1}{r} \frac{\partial (p^2)}{\partial r} \right] \qquad (1)$$

- $p$ pressure, psia
- $K$ permeability, millidarcys
- $\mu$ average viscosity, centipoise
- $\phi$ fractional porosity
- $r$ radius, feet
- $\theta$ time, minutes

Once solved for a given type of flow problem, Equation (1) will permit the calculation of the pressure at any point in the reservoir at any time. These solutions may be used again and again for all problems of the same type, such as constant flow rate problems. If another type of problem, such as varying rate of flow at a constant back pressure, is to be solved, new mathematical or computer solutions must be provided before routine field calculations can be made.

The application of solutions of Equation 1 to field problems is considerably simplified by the use of dimensionless groups of variables. Four of the important dimensionless groups are the dimensionless time group, the dimensionless flow rate group, the dimensionless pressure ratio, and the dimensionless radius ratio. The dimensionless time group for gas flow is:

$$\ominus = \frac{4.39\ (10^{-6})\ K\bar{p}\theta}{\mu\phi r_w^2} \qquad (2)$$

- $\ominus$ dimensionless time number
- $K$ permeability, millidarcys
- $\bar{p}$ average reservoir pressure, psia
- $\theta$ time that the well has been flowing, minutes
- $\mu$ average gas viscosity, centipoise
- $\phi$ fractional porosity
- $r_w$ well bore radius, feet

**TABLE 1**

**Values of the Dimensionless Draw Down Number for Constant Flow Rate, Radial Flow in Infinite Reservoirs by Van Everdingen and Hurst[1]**

| Dimensionless Time Θ | Dimensionless Draw Down Number PΘ |
|---|---|
| 0.01 | 0.112 |
| 0.05 | 0.229 |
| 0.10 | 0.315 |
| 0.15 | 0.376 |
| 0.20 | 0.424 |
| 0.25 | 0.469 |
| 0.30 | 0.503 |
| 0.40 | 0.564 |
| 0.50 | 0.616 |
| 0.60 | 0.659 |
| 0.70 | 0.702 |
| 0.80 | 0.735 |
| 0.90 | 0.772 |
| 1.0 | 0.802 |
| 1.5 | 0.927 |
| 2.0 | 1.020 |
| 2.5 | 1.101 |
| 3.0 | 1.169 |
| 4.0 | 1.275 |
| 5.0 | 1.362 |
| 6.0 | 1.436 |
| 7.0 | 1.500 |
| 8.0 | 1.556 |
| 9.0 | 1.604 |
| 10.0 | 1.651 |
| 15 | 1.829 |
| 20 | 1.960 |
| 25 | 2.067 |
| 30 | 2.147 |
| 40 | 2.282 |
| 50 | 2.388 |
| 60 | 2.476 |
| 70 | 2.550 |
| 80 | 2.615 |
| 90 | 2.672 |
| 100 | 2.723 |
| 150 | 2.921 |
| 200 | 3.064 |
| 250 | 3.173 |
| 300 | 3.263 |
| 400 | 3.406 |
| 500 | 3.516 |
| 600 | 3.608 |
| 700 | 3.684 |
| 800 | 3.750 |
| 900 | 3.809 |
| 1000 | 3.860 |

The dimensionless flow rate group is:

$$m = \frac{1424\ \mu\ z\ TQ}{hKo_f^2} \qquad (3)$$

- $m$ dimensionless flow rate number
- $\mu$ average viscosity, centipoise
- $z$ average compressibility factor
- $T$ absolute temperature, ° Rankine = °Fahrenheit + 460
- $Q$ gas production rate, Mcf/D at 14.7 psia and 60° F
- $h$ producing formation thickness, feet
- $K$ permeability, millidarcys
- $p_f$ shut in reservoir formation pressure, psia

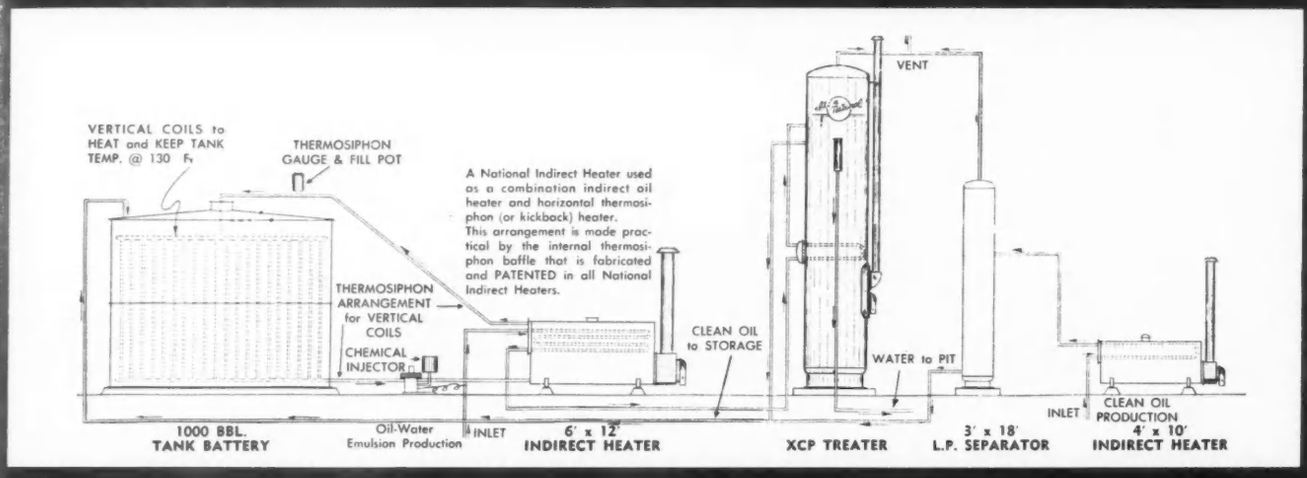
The dimensionless pressure ratio is $p/p_f$ where p is the pressure in psia and $p_f$ is the shut in reservoir formation pressure in psia. The dimensionless radius ratio is $r/r_w$ where r is the radius to any point in feet and $r_w$ is the well bore radius in feet. In addition to these four groups, Van Everdingen and Hurst use a dimensionless draw down group, $P_\theta$, which will be discussed in the following section. $P_\theta$ is identical with Van Everdingen and Hurst's $P_t$.

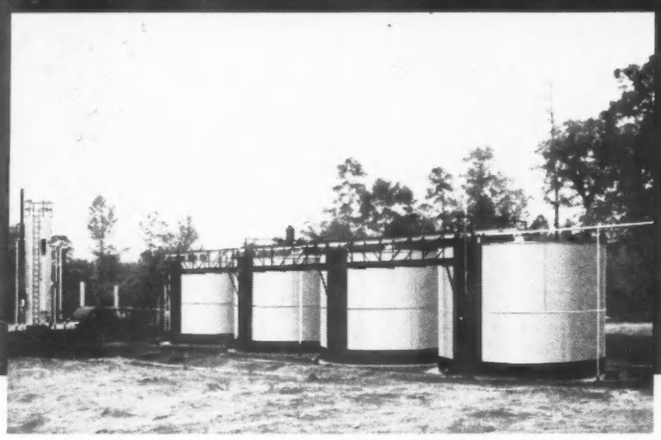
The equation for the unsteady state radial flow of liquids is very similar to the flow equation for gases given as Equation 1. Van Everdingen and Hurst have solved the equation for liquid flow for several types of practical oil reservoir problems. Examination of the theory shows that their solutions can be adapted to gas reservoir problems when the proper equations and units are used. The procedure for solving gas flow problems will now be presented for the case of constant production rates of natural gas.

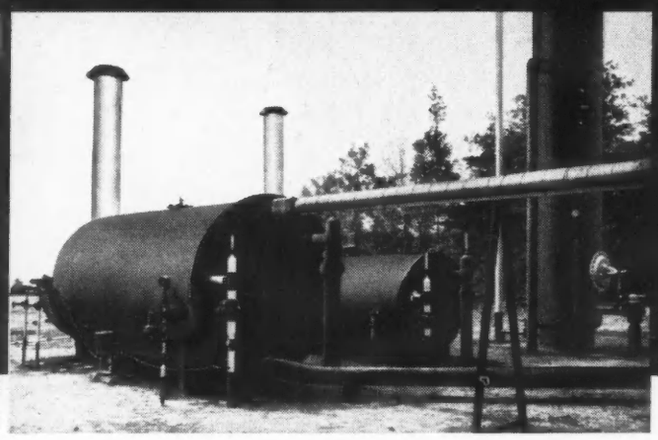
**Van Everdingen and Hurst Solution.** The Van Everdingen and Hurst solution for a constant production rate is presented in terms of another dimensionless group $P_\theta$. This dimensionless group gives the pressure draw

# NATIONAL SOLVES ANOTHER PROBLEM

| CONDITIONS | REQUIREMENTS | SOLUTION |
|---|---|---|
| 18° API Gravity, Asphalt Base Foaming Oil Production<br>One Well Producing no emulsion<br>One Well Producing 20% cut emulsion<br>Low GOR, Approx. 200 to 1<br>High Temperature pour point crude | De-gas Crude<br>Reduce Emulsion<br>Maintain storage temp. at approx. 130° so pipeline can pump oil out of storage. | Use 4 x 10 Ind. Heater to preheat clean production for degassing.<br>Use 3 x 18 Separator to degas clean crude.<br>Use 6 x 12 Ind. Heater to preheat emulsion, AND to provide heat to the thermosiphon vertical coil system in storage tank.<br>Use XCP Treater to de-gas emulsion and dewater the crude. |


VERTICAL COILS to HEAT and KEEP TANK TEMP. @ 130 F.
THERMOSIPHON GAUGE & FILL POT
A National Indirect Heater used as a combination indirect oil heater and horizontal thermosiphon (or kickback) heater. This arrangement is made practical by the internal thermosiphon baffle that is fabricated and PATENTED in all National Indirect Heaters.
THERMOSIPHON ARRANGEMENT for VERTICAL COILS
CHEMICAL INJECTOR
CLEAN OIL to STORAGE
VENT
WATER to PIT
INLET
CLEAN OIL PRODUCTION
1000 BBL. TANK BATTERY
Oil-Water Emulsion Production
INLET
6' x 12' INDIRECT HEATER
XCP TREATER
3' x 18' L.P. SEPARATOR
4' x 10' INDIRECT HEATER





Good production is preheated in the small indirect heater then flows directly into insulated separator for degassing after heating. Emulsion crude flows through large indirect heater for preheating and chemical application then into preheating coil of National XCP Treater.

Unique in this hook-up is the method used to maintain 130 degrees temperature on the storage tanks. Each of the storage tanks contains a set of vertical coils that are used as heat exchangers. Hot water flows through these coils. The water is circulated thermosiphonically between the water bath of the large indirect heater and the coils in the tanks.

This entire arrangement is so complete that it requires very little of the pumper's time, thus, releasing him to other lease duties in addition to this lease. The treating problem on this lease represented a most difficult situation because the production was foaming and because the emulsion produced from these foaming wells was finely cut and because the viscosity of the oil was very high and because the storage tanks had to be maintained at such a high temperature.

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down from the reservoir pressure ($p_f - p$) for a certain flow rate. Usually, the draw down at the well bore ($p_f - p_s$) is considered, where $p_f$ is the shut in formation pressure and $p_s$ is the flowing pressure at the well bore. However, the draw down at any point in the reservoir can be computed if desired. The draw down at other flow conditions is proportional to the flow rate and the viscosity and inversely proportional to the permeability-feet of the formation, as in Equation 4.

$$p_f - p_s = \frac{q_T \mu P_\Theta}{2\pi hK} \qquad (4)$$

- $q_T$ volumetric flow rate, cm³/sec at reservoir conditions
- $\mu$ average viscosity, centipoise
- K permeability, darcys
- h formation thickness, cm
- $p_f$ shut in formation pressure, atmospheres
- $p_s$ flowing bottom hole pressure, atmospheres
- $P_\Theta$ dimensionless draw down number

The draw down at a point other than the well bore may be found by using that radius in evaluating the dimensionless time group, to be discussed next.

The value of $P_\Theta$ depends solely upon the dimensionless time $\Theta$ for the type of flow problem being considered. The Van Everdingen and Hurst solution gives the relationship of $P_\Theta$ with $\Theta$. For dimensionless times less than values of 1,000, $P_\Theta$ is given in Table 1 taken from the work of Van Everdingen and Hurst. At greater values of dimensionless time these authors showed that $P_\Theta$ can be calculated accurately from Equation 5.

$$P_\Theta = \tfrac{1}{2}\,(2.3026 \log_{10} \Theta + 0.80907) \qquad (5)$$

**Derivation of Gas Flow Relationships.** In order to make use of the Van Everdingen and Hurst solution for gas flow problems, Equation 4 must be put into natural gas terminology and units.

$$q_T = \frac{(2.54^3)\,(12^3)\,(z)\,(10.73)\,(T)\,(1000)\,(Q)}{(24)\,(60)\,(60)\,(\bar{p})\,(379)} = \frac{9.28\,z\,TQ}{\bar{p}} \qquad (6)$$

- $q_T$ cm³/sec
- T ° Rankine
- Q Mcf/D at 14.7 psia and 60° F
- $\bar{p}$ psia
- z no units

Equation 4 then becomes:

$$p_f - p_s = \frac{9.28\,(14.7)\,(1000)\,Qz\,T\mu\,P_\Theta}{2\pi\,(12)\,(2.54)\,\bar{p}Kh} = \frac{712\,QzT\mu P_\Theta}{\bar{p}Kh} \qquad (7)$$

- $p_f$ reservoir shut in formation pressure, psia
- $p_s$ flowing bottom hole pressure, psia
- Q flow rate, Mcf/D at 14.7 psia and 60° F
- z average compressibility factor
- T reservoir temperature, ° Rankine
- $\mu$ average viscosity, centipoise
- $\bar{p}$ average reservoir pressure, psia
- K permeability, millidarcys
- $P_\Theta$ dimensionless draw down number
- h formation thickness, feet

The dimensionless pressure ratio at the well bore, $p_s/p_f$, can be found from Equation 8.

$$p_s/p_f = 1 - \frac{mp_fP_\Theta}{2\bar{p}} \qquad (8)$$

all units as in Equation 7

It can be seen that knowledge of the flowing conditions together with values of $P\Theta$ will suffice to calculate draw down pressures.

**Application to Natural Gas Flow Problems.** The procedure for using the Van Everdingen and Hurst solution for constant production rate flow problems in infinite reservoirs will now be given. Suppose that a shut-in gas well is opened to a constant rate of flow for several hours. At the end of the flow period the flowing bottom-hole pressure draw down is to be calculated.

Step 1—Calculate the dimensionless time for gas flow using Equation 2 with the units and conversion factors as given.

Step 2—Using Table 1 or Equation 4, obtain the dimensionless draw down number $P_\Theta$.

Step 3—Calculate the dimensionless flow rate m from Equation 3.

Step 4—Calculate $p_s/p_f$ from m, $p_f$, $\bar{p}$, and $P_\Theta$ using Equation 8.

The draw down pressure at the well bore is then known.

If the draw down pressure at some radius other than at the well bore is desired, the value of dimensionless time $\Theta$ is found by using that value of the radius in Equation 2 rather than the value of $r_w$. The procedure to be followed is then exactly the same as before. The pressure draw down calculated will be that at the new radius value used.

**Illustrative Problem.** A shut-in natural gas well is produced at a rate of 3000 Mcf/D for 5.0 hours. The gas properties and formation characteristics are as follows:

Formation temperature 180° F.
Shut-in formation pressure 2300 psia
$z = 0.89$
$\mu = 0.0168$ centipoise
$h = 12$ feet
$K = 28$ millidarcys
$r_w = 0.5$ feet
$\phi = 15$ percent porosity

The pressure at the well bore at the end of the 5.0 hours is to be calculated.

Solution:

Estimate $\bar{p}$ to be 2,200 psia.

$$\Theta = \frac{(4.39)\,(10^{-6})\,(28)\,(2,200)\,(5)\,(60)}{(0.0168)\,(0.15)\,(0.25)} = 128,800$$

$$P_\Theta = \tfrac{1}{2}\,(2.3026 \log_{10} 128,800 + 0.80907) = 6.2882$$

$$m = \frac{(1,424)\,(0.0168)\,(0.89)\,(640)\,(3,000)}{(12)\,(28)\,(2,300^2)} = 0.023$$

$$p_s/p_f = 1 - \frac{(0.0230)\,(2,300)\,(6.2882)}{(2)\,(2,200)} = 0.9244$$

$$p_s = (0.9244)\,(2,300) = \underline{2,126} \text{ psia Answer}$$

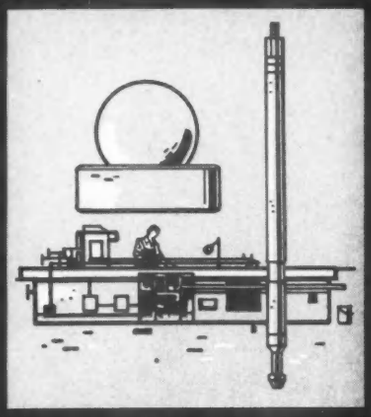
It is to be noted that the assumed value of $\bar{p}$ is satisfactory.


REFERENCE

[1] Van Everdingen, A. F. and Hurst, W. "The Application of the Laplace Transformation to Flow Problems in Reservoirs" Trans. A.I.M.E. 186 305 (1949).


## About the Author

DAVID CORNELL is a former assistant professor of chemical engineering at the University of Texas and is now with Monsanto Chemical Company at Dayton, Ohio. In addition to his teaching experience, Dr. Cornell's background includes two summers with the Texas Petroleum Research Committee and the University of Texas and two years with Blaw-Knox Company's Research and Development department. He holds three chemical engineering degrees, bachelors, masters and doctors, from the University of Michigan.



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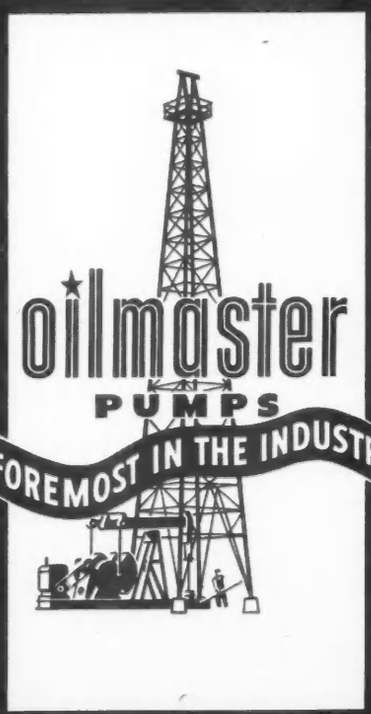


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*Sinking Canadian sun silhouettes a flowing well under perfect control. Good safety practices exercised in its completion made certain that . . .*

# All's Well on This Flowing Well

**Planning, proper tools and supervision will reduce hazards of well completions. An expert tells what to do about—drill stem testing, removing tool joint plugs, dislodging cores, running production casing, and other frequent hazards.**

**By K. H. GIBSON,** Area Superintendent, Canadian Gulf Oil Company, Stettler, Alberta, Canada

WELL COMPLETION operations should be more rigidly supervised than ordinary drilling operations and it is the duty of the contractor and operator to provide competent supervision during such operations. Drilling crews skilled in general drilling practices are not necessarily skilled in the art of well completion. It is not uncommon to find that some members of a drilling crew have had no experience in running casing and tubing or in swabbing operations. This lack of experience greatly increases the hazards involved in this type of operation. With proper forethought, the correct tools, and constant supervision, most of the serious risks involved can be overcome.

**Drill stem testing.** One of the most hazardous phases of rig work is drill stem testing. There have been many serious accidents and some fatalities during such operations. Following are

five safety measures that should be taken prior to testing: (1) Assure that the condition of the hole is suitable for the running and pulling of the packer; (2) Accessories needed for testing, such as drill pipe plugs and a mud bucket with correct size rubbers installed and in good condition, should be on hand; (3) A bleed-off line from the rig floor to the reserve pit should be installed; (4) A flare line should be secured to the ground and extended a safe distance from the rig; and (5) Gas masks should be provided for the entire crew.

The testing company's equipment should be inspected, with particular attention being paid to all surface equipment, swivel type joints, manifold and connections. A drill stem test should never be taken without a high-pressure valve being in place immediately on top of the drill pipe string. If a test runs into dusk, operations should be suspended until daylight. In such a case, a drill pipe plug should be placed in the tool joint at the top of the drilling string and the drilling string should be moved a few times each hour to prevent the packer from sticking. When it is daylight, the pipe can be bled down through the flow line and pulling resumed.

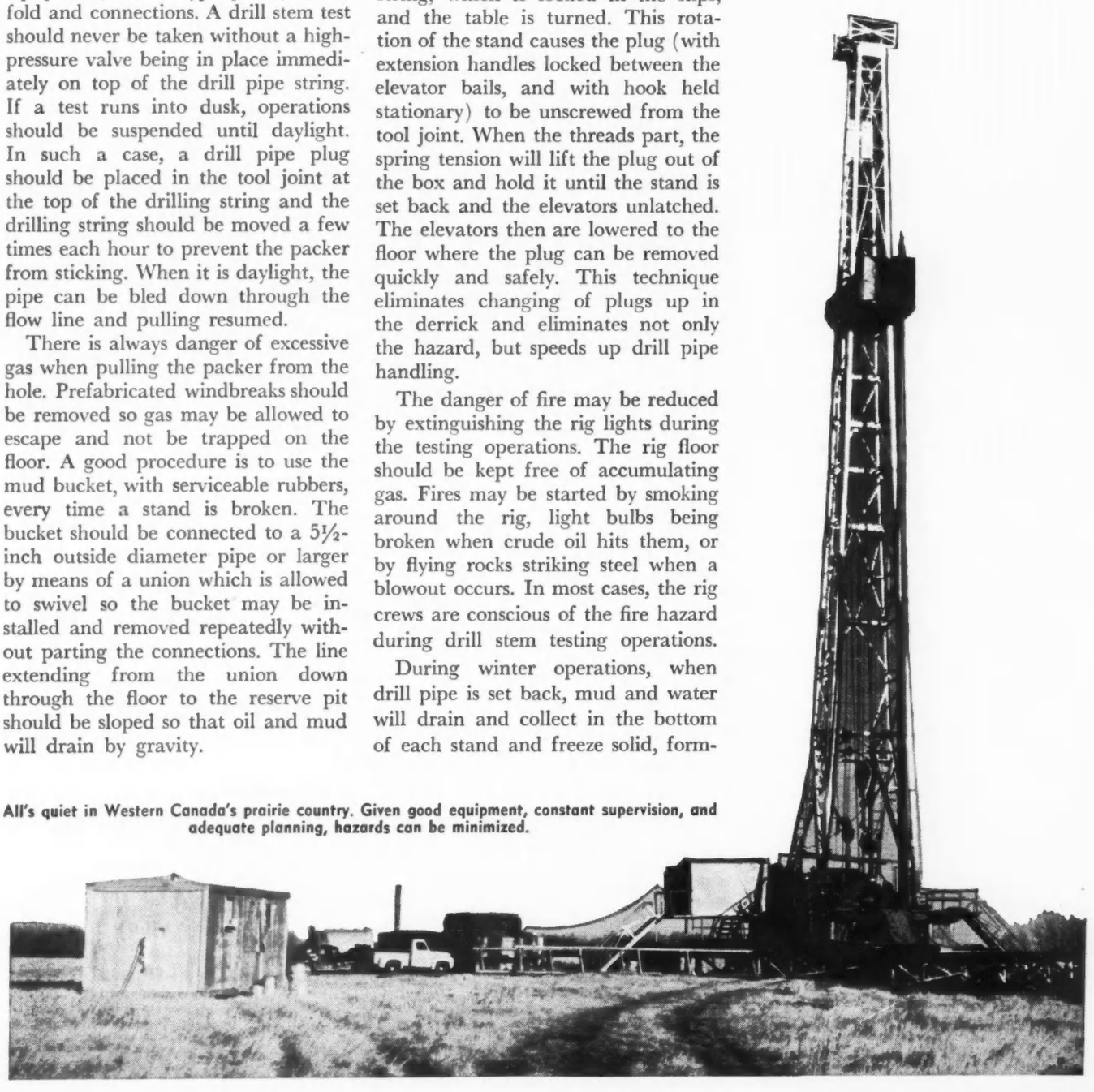
There is always danger of excessive gas when pulling the packer from the hole. Prefabricated windbreaks should be removed so gas may be allowed to escape and not be trapped on the floor. A good procedure is to use the mud bucket, with serviceable rubbers, every time a stand is broken. The bucket should be connected to a 5½-inch outside diameter pipe or larger by means of a union which is allowed to swivel so the bucket may be installed and removed repeatedly without parting the connections. The line extending from the union down through the floor to the reserve pit should be sloped so that oil and mud will drain by gravity.

**Tool joint plug.** Removing the drill pipe plug each time a stand is set back can be hazardous and the derrick man has to be cautious to avoid dropping it on the men working on the floor. Several methods may be employed for removing this plug from the tool joint so that it can be lowered with the blocks. One successful method involves the use of a spring, under slight tension, which is attached to the plug bail and secured to the hook. In addition, the horizontal "T" handles welded to the plug should be sufficiently long to project outward beyond the bails of the elevators.

In operation, the stand is parted and drained. It is then set on the drill string, which is locked in the slips, and the table is turned. This rotation of the stand causes the plug (with extension handles locked between the elevator bails, and with hook held stationary) to be unscrewed from the tool joint. When the threads part, the spring tension will lift the plug out of the box and hold it until the stand is set back and the elevators unlatched. The elevators then are lowered to the floor where the plug can be removed quickly and safely. This technique eliminates changing of plugs up in the derrick and eliminates not only the hazard, but speeds up drill pipe handling.

The danger of fire may be reduced by extinguishing the rig lights during the testing operations. The rig floor should be kept free of accumulating gas. Fires may be started by smoking around the rig, light bulbs being broken when crude oil hits them, or by flying rocks striking steel when a blowout occurs. In most cases, the rig crews are conscious of the fire hazard during drill stem testing operations.

During winter operations, when drill pipe is set back, mud and water will drain and collect in the bottom of each stand and freeze solid, forming a plug of from a few inches to a foot in length. Unless this formation of ice plugs is avoided, either or both of two things can result: (1) When the pipe is re-run into the hole for a drill stem test, mud and water will melt with the increasing earth temperature and will settle in the bottom of the string immediately above the test tool. By the time the string is run and the test is to be made, there may be as much as 30 to 40 feet of fluid (depending upon depth of hole) immediately above the tool. When the dart is dropped, the fluid may suffi-



**All's quiet in Western Canada's prairie country. Given good equipment, constant supervision, and adequate planning, hazards can be minimized.**

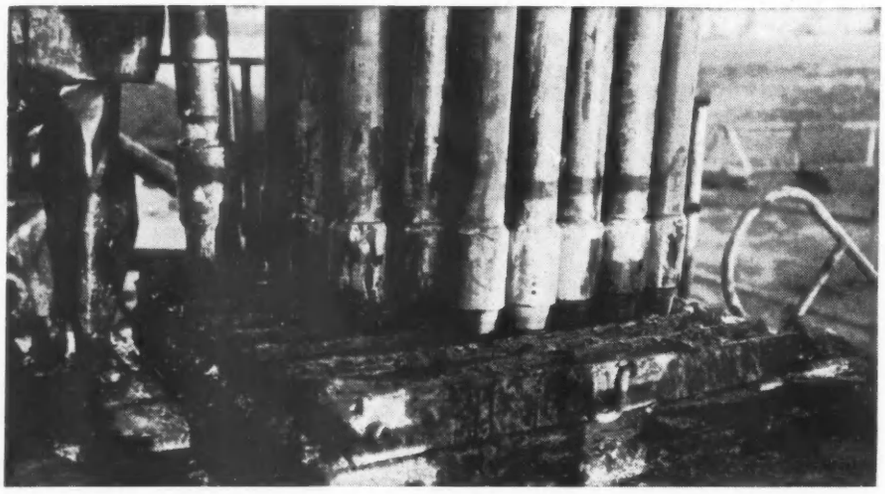


FIGURE 1—Drill pipe platform with ribs to facilitate standing pipe in even rows.

ciently retard its fall and may fail to break the disk, thus requiring another round trip in order to clean the drill pipe; (2) After testing, when pipe is re-run into the hole with ice plugs still in the bottom of each stand, higher hole temperatures gradually will melt the plugs and, due to the differential pressure created between the mud-filled hole and the open drill pipe above the plug, the loosened ice plugs suddenly will be blown up the pipe, sometimes going up into the derrick and falling back on the floor with possible injury to crew personnel.

A method commonly employed to avoid formation of such ice plugs consists of setting back pipe on a specially-constructed steel platform, or chest (Figure 1) through which steam or hot water is circulated, providing sufficient heat to prevent formation of ice plugs and allowing fluid to drain out of the stands normally.

A common hazard when testing is a wet and slippery floor. There may be a certain amount of leakage of oil from the drill pipe even when a mud bucket is used. Careful handling of the tongs and shutting down occasionally to wash the floor and table can reduce the number of hand and foot injuries and strained backs.

Frozen or plugged lines, after the tool is open, can result in the building up of excessive pressure. It therefore is important that all surface flow lines be steamed out and dry before the test is started.

A kill line should be in place and the blowout preventer equipment in good working condition. Steam coils or hot air blowers should be installed if necessary to prevent freezing-up of the rams during cold weather.

Water cushions should be used for expected large gas flows and for testing at depths at which drill pipe failure through collapse becames a factor.

The hole should be kept full at all times and watched closely for swabbing action while pulling the packer. Inasmuch as the first 1000 feet or so of open hole above the pay zone is likely to be more nearly to gage, the tester should be pulled more cautiously through that interval to minimize swabbing action. Above that point, pipe can be pulled a little faster.

An inexpensive and safe method of keeping the hole full at all times is to keep a pump going continuously, pumping mud into the hole through the fill-up line in the preventer. When the hole fills, excess mud flows up into the drilling nipple and on out through the mud return line to the pits. With such a hookup, when pipe is being pulled, it is only necessary for the crew to close off the stand pipe valve and open the fill-up line. This keeps the hole filled at all times and keeps overflow mud off the derrick floor. Of added importance in Western Canada winter operations is the fact that this method keeps the surface mud system thawed out and in good working condition.

**Dislodging cores.** Frequently, after the presence of oil or gas has been determined by either drill stem testing, or other means, the next step is coring. The most common injuries to rig personnel in connection with coring are injuries to hands or toes while removing the core from the barrel. This type of injury results from a section of the core being lodged in the inner barrel and not dropping down when the core preceding it has been removed. If a portion of a core remains lodged in the barrel, one of the men, by jarring on the outer barrel with a hammer, may cause the remaining core to suddenly dislodge and if a hand or foot is in the danger area, serious injury can result. In spite of it being a simple thing to stand aside to avoid this type of injury, it is quite a common occurrence. The safest procedure is to lay the inner barrel down on the walk, then ram out the lodged core section.

**Running casing.** An operator is most anxious to have the hole cased when oil or gas of commercial quantity has been assured. Some of the operations from which injuries more frequently will result while running casing are:

**1.** Laying down drill pipe prior to running casing. Use of the trolley or highline, eliminating the wagon, is helping to remove this source of injuries.

**2.** Changing rams in blowout preventers. Preventers should be steamed or warmed up before opening. Oftentimes a "mountain" of frozen mud and ice becomes built up around the preventer. Some contractors use one, sometimes two, steam coils, one on each side of the preventer to keep it free and in operating condition. Enclosing the cellar area and using hot air blowers also serve to minimize danger of freezing during winter operations.

**3.** Rolling casing from rack to walk. Caution should be exercised to avoid mashed toes or fingers.

**4.** Bringing casing through "V" door. When catline is used, care should be taken that joint does not "ram" someone on walk or rig floor.

**5.** Unsafe pick-up line and sling. Lines soon become frayed. Pick-up elevators should be used.

**6.** Stabbing board breaking or falling, or a person being knocked off the

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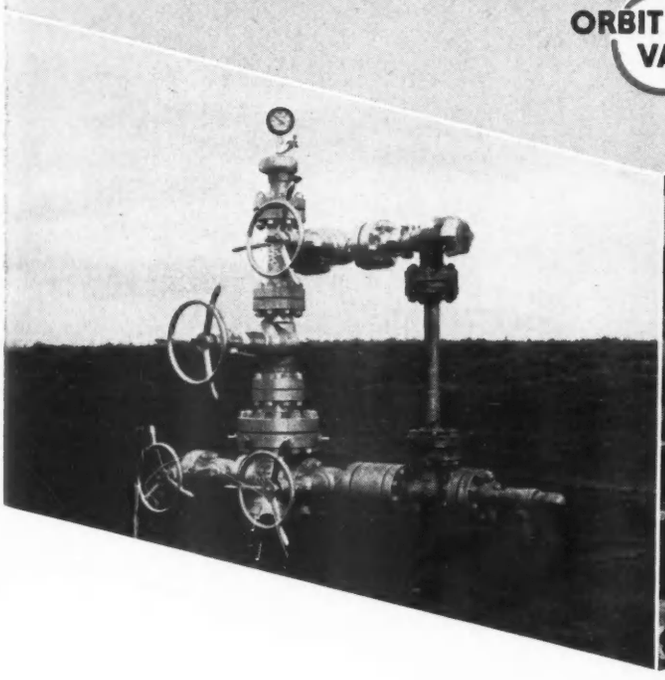

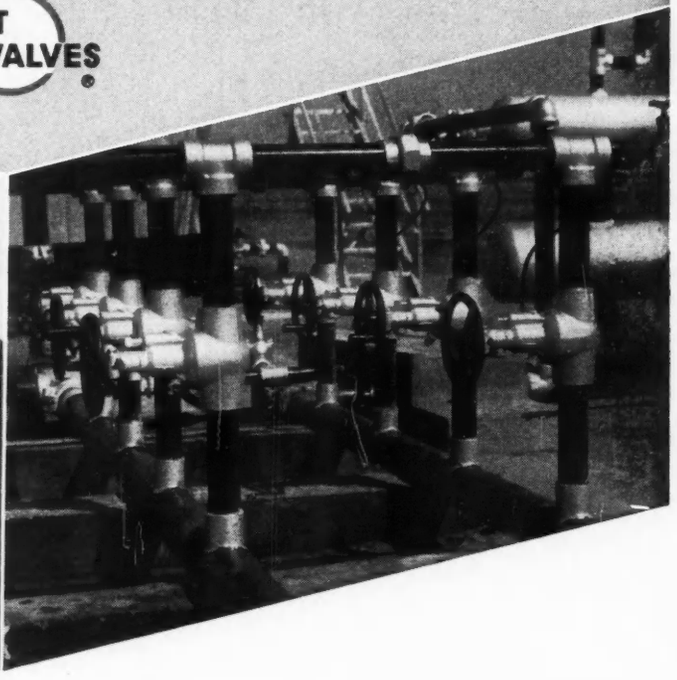

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board by swinging blocks. Personnel should step back out of the danger area if the blocks are swinging.

**7.** Floors muddy or ice-covered are dangerous at all times. Non-skid materials should be installed at danger points. Some operators use a fibrous, absorbent type material.

**8.** Long hours resulting in men becoming fatigued and not as alert as they normally would be.

Prior to casing a hole, the drilling line and all tools should be inspected. Sufficient lines should be strung to the blocks to avoid overloads. Safe high-pressure lines and fittings should be used during cementing operations and a swage should be available at all times while running casing.

This swage, which screws into the open collar of the casing, has welded or screwed into it a short two-inch nipple to which, in turn, is attached a half-union. This half-union is to be connected to the half-union on the lower end of the rotary hose, the latter being disconnected at the gooseneck. By using the rotary hose, a twofold advantage is gained: (1) the swage may be used for filling the pipe to avoid creating a mess on the floor, and (2) it permits circulating mud into the hole immediately if the well starts to kick over. A fill-up line equipped with a half-union also may be used with the swage if the rotary hose is not employed.

Another factor to consider is that running casing is a change in the regular work procedure of the drilling crew. The crew, not being as familiar with this work as with their regular day-to-day duties, are more prone to accidents.

**Handling tubing.** Most of these hazards concerning casing jobs apply also to tubing jobs, but to a somewhat lesser degree. Tubing frequently is run or pulled while the hole is loaded with oil and, of course, this increases the danger of fire. The floor can become quite slippery when working with oil and should be hosed down regularly and kept as clean as possible.

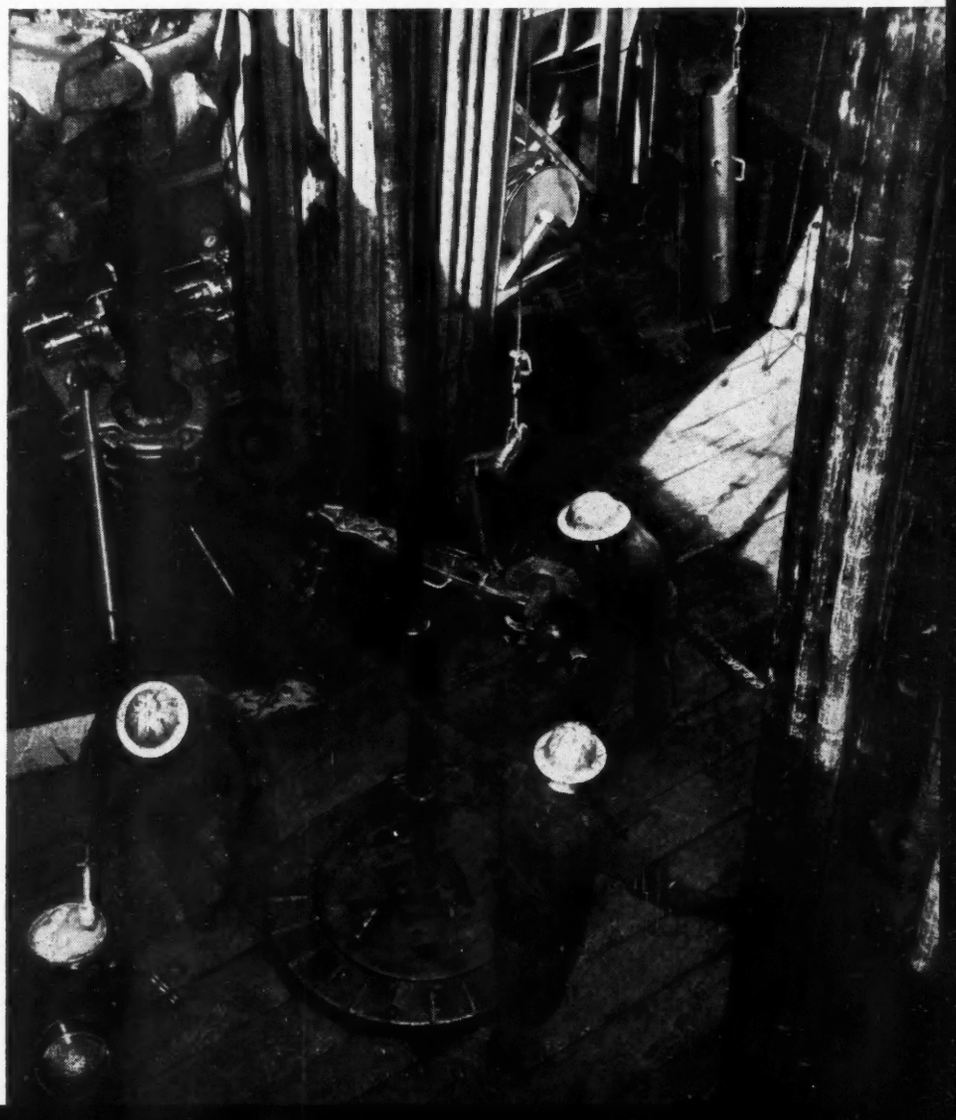
The proper size tools for the size tubing being handled always should be used. There is a common fault among rig crews to use pipe wrenches instead of tubing tongs and to use the cathead for breaking out or making up work, instead of using a swamp pipe or snipe. The use of wrenches is very dangerous as the wrench might slip or jump off the tubing and strike another man. Many injuries to arms and legs have been sustained in this manner. Using a rope from the end of a wrench to the cathead to break out tubing is also unsafe. The wrench often is not of sufficient strength to withstand the pull and may well break under the strain, with the possible result that the driller or cathead man may be struck with flying steel.

**Displacing with oil.** It is the practice of some operators to displace the fluid in the hole after the tubing has been landed and after the wellhead connections have been secured. This is done by using the rig pump. Drilling mud first is circulated out of the hole using fresh water. This has a washing or cleaning effect on the formation and casing. The fresh water is then circulated out by pumping oil into the hole. This cleans the entire hole and the well will more readily produce pipe line oil.

Crude oil must be hauled from the storage tanks by tank trucks to supply the rig pump. Extreme caution should be used in this operation. The oil should be pumped directly from the tank truck to the suction on the rig pump, and not dumped into an open pit to be picked up later. One fatality in Alberta's Redwater field was the direct result of a fire which occurred when a truck was being unloaded into an open pit. The tank on the truck blew up and the driver was fatally injured.

The wellhead assembly should be a completely closed system with a bleed-off line to the pit. As the fluid is lightened in the hole by displacing the heavier mud and water, some wells will start to flow without benefit of swabbing. The hook-up should be such that if a well "brings itself in," continuous flowing will be possible to the pit or stock tank. Of course, the

**Coming out of the hole in Western Canada. Care and proper tools will avoid delays and eliminate accidents.**



rule of no smoking or allowing open fires in the vicinity should be strictly enforced during a displacing job. Hydrogen sulfide gas may be present and gas masks should be provided for this emergency. Displacing is done occasionally at night and, while this is not good practice, it sometimes is necessary. When displacing at night it is good planning to always have two members of the crew working together so that, in case of a fire or gas accident, one man can help the other.

**Swabbing hazards.** More hazards exist when swabbing operations are in progress than can be elaborated upon at this time. One hazard, however, that can be mentioned, results when going into the hole too fast and having the swab tool strike gas pockets or fluid. This results in the throwing of a loop in the sand line. The line should be watched closely to avoid slack when running in.

Men should not stand too closely to the fast-moving drum when guiding the sand line. It is possible to have clothes fouled and pulled into the moving lines and machinery.

Particular care should be taken to guard against fire and smoking. Lights or open fires should be prohibited. If the oil saver does not work properly, or if the swab is popped out of the lubricator, the rig and equipment could be immediately covered with highly inflammable oil.

The lubricator should be of sufficient length to accommodate the swab and sinker bars. It should also be equipped with a valve at the bottom, close to the christmas tree. The lubricator itself should be snubbed with four lines to convenient points of the rig.

The sand line should be flagged, at the drum, at a point where the swab is 6 to 7 feet from entering the lubricator. This will enable the operator to have a warning as to when to slow down the travel. This will avoid popping the swab out of the lubricator, with resultant oil spray and fire hazard.

**Acidizing.** Acidizing is the most common remedial work that is done to make a well flow. Quite often, at completion, an acid wash or pressure treatment is all that is required. Sometimes the acid job is done while the drilling rig is still over the hole, while at other times a service rig is used. In either case, the hazards involved are the same. Before starting an acid job, all surface lines should be pressure tested in excess of the expected pressure required to inject acid into the formation. Serious injuries may occur from failure to take this precaution. In the event the lines leak under pressure while pumping acid, workmen might suffer bad acid burns. It is desirable to have plenty of fresh water available to wash eyes or skin in the event of an accident. Breakage of fittings or lines under pressure may also cause injury from flying steel.

The danger of fire from oil or gas while acidizing must be considered very carefully and fire extinguishers should be placed both at the wellhead and at the pump truck. No one should be allowed near the truck, lines, or wellhead, except when absolutely necessary. All visitors or workmen not actively engaged in this work should remain at a safe distance.

**Squeeze jobs.** A cementing job is one that must be done at extreme pressure and, in most cases, one that requires good supervision and great caution. Here again, as in acid work, all lines should be pressure tested before the job of squeezing is begun. On normal cementing jobs, the fluid in the hole should be mud or water. This fluid should have been circulated sufficiently to be gas free and to insure that there are no gas pockets in the annulus. This job should not be done with oil in the hole if it can possibly be avoided.

Bleed-off lines should be in place from the blowout preventers to the pit. The preventer rams should be closed while spotting the cement to the bottom and during the actual squeezing operation. With the rams closed and the bleed-off line open, all overflow or returns from the well will flow to the pit safely and the hazard of fire is virtually eliminated. Another safety point to remember is always to bleed off the pressure before tightening fittings when a leak has developed. Here again, men should avoid standing close to lines under high pressure except when absolutely necessary.

**Perforating.** Some wells are completed by setting the casing through the productive formation, cemented, then perforated, with crude oil being used to load the hole during the perforating operation. Use of crude often causes a slippery, messy condition around the well and the danger of fire as well as injury to personnel is, therefore, greater. Premature detonation of perforating guns on the surface is very remote since service companies are extremely careful in this operation. However, some operators require their personnel to remain a safe distance from the well during perforating or shooting operations, or at least while the guns are on the surface. There always is the possibility of the well coming in after being perforated. The gun should be pulled slowly from the hole to minimize swabbing action. A lubricator and stuffing box for the shooting line and gun always should be used. A bleed-off line also should be in place above the master gate.

**Hydrogen sulfide gas.** A great deal has been written and discussed on the subject of hydrogen sulfide gas. The principal hazard from this is poisoning by inhalation. This danger exists chiefly in cellars or under substructures on wells where there are possible accumulations of gas. Gas masks should be provided when its presence is anticipated. Where possible, cellars should be ventilated with blowers before crews enter. Rig employes should be familiar with first aid treatment for hydrogen sulfide gas poisoning. Maximum care should be taken to prevent escape of fumes into the air of working places. Before entering air suspected of containing hydrogen sulfide, a test should be made to determine whether or not the gas is present. No one should attempt to determine the presence of gas by its odor and no one should enter a tank, cellar or other enclosed place where gas has accumulated without wearing proper respiratory protection equipment and a safety belt secured to a life line held by another person outside.

There is no substitute for planning, proper tools for the job, and supervision. A big job lies ahead for supervisors: training all personnel in the practice of safety will eliminate accidents more effectively than any one thing that can be done by the industry today.

**ACKNOWLEDGMENT**

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**—The End**

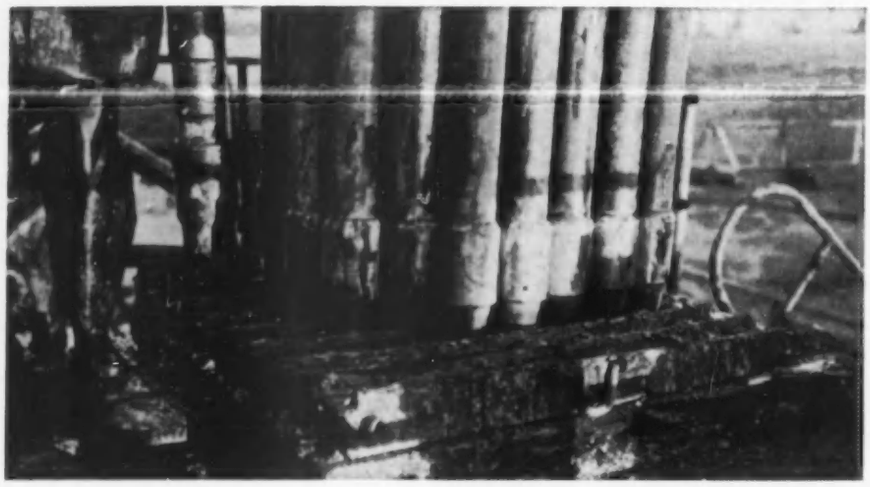


FIGURE 1—Drill pipe platform with ribs to facilitate standing pipe in even rows.

ciently retard its fall and may fail to break the disk, thus requiring another round trip in order to clean the drill pipe; (2) After testing, when pipe is re-run into the hole with ice plugs still in the bottom of each stand, higher hole temperatures gradually will melt the plugs and, due to the differential pressure created between the mud-filled hole and the open drill pipe above the plug, the loosened ice plugs suddenly will be blown up the pipe, sometimes going up into the derrick and falling back on the floor with possible injury to crew personnel.

A method commonly employed to avoid formation of such ice plugs consists of setting back pipe on a specially-constructed steel platform, or chest (Figure 1) through which steam or hot water is circulated, providing sufficient heat to prevent formation of ice plugs and allowing fluid to drain out of the stands normally.

A common hazard when testing is a wet and slippery floor. There may be a certain amount of leakage of oil from the drill pipe even when a mud bucket is used. Careful handling of the tongs and shutting down occasionally to wash the floor and table can reduce the number of hand and foot injuries and strained backs.

Frozen or plugged lines, after the tool is open, can result in the building up of excessive pressure. It therefore is important that all surface flow lines be steamed out and dry before the test is started.

A kill line should be in place and the blowout preventer equipment in good working condition. Steam coils or hot air blowers should be installed if necessary to prevent freezing-up of the rams during cold weather.

Water cushions should be used for expected large gas flows and for testing at depths at which drill pipe failure through collapse becames a factor.

The hole should be kept full at all times and watched closely for swabbing action while pulling the packer. Inasmuch as the first 1000 feet or so of open hole above the pay zone is likely to be more nearly to gage, the tester should be pulled more cautiously through that interval to minimize swabbing action. Above that point, pipe can be pulled a little faster.

An inexpensive and safe method of keeping the hole full at all times is to keep a pump going continuously, pumping mud into the hole through the fill-up line in the preventer. When the hole fills, excess mud flows up into the drilling nipple and on out through the mud return line to the pits. With such a hookup, when pipe is being pulled, it is only necessary for the crew to close off the stand pipe valve and open the fill-up line. This keeps the hole filled at all times and keeps overflow mud off the derrick floor. Of added importance in Western Canada winter operations is the fact that this method keeps the surface mud system thawed out and in good working condition.

**Dislodging cores.** Frequently, after the presence of oil or gas has been determined by either drill stem testing, or other means, the next step is coring. The most common injuries to rig personnel in connection with coring are injuries to hands or toes while removing the core from the barrel. This type of injury results from a section of the core being lodged in the inner barrel and not dropping down when the core preceding it has been removed. If a portion of a core remains lodged in the barrel, one of the men, by jarring on the outer barrel with a hammer, may cause the remaining core to suddenly dislodge and if a hand or foot is in the danger area, serious injury can result. In spite of it being a simple thing to stand aside to avoid this type of injury, it is quite a common occurrence. The safest procedure is to lay the inner barrel down on the walk, then ram out the lodged core section.

**Running casing.** An operator is most anxious to have the hole cased when oil or gas of commercial quantity has been assured. Some of the operations from which injuries more frequently will result while running casing are:

**1.** Laying down drill pipe prior to running casing. Use of the trolley or highline, eliminating the wagon, is helping to remove this source of injuries.

**2.** Changing rams in blowout preventers. Preventers should be steamed or warmed up before opening. Oftentimes a "mountain" of frozen mud and ice becomes built up around the preventer. Some contractors use one, sometimes two, steam coils, one on each side of the preventer to keep it free and in operating condition. Enclosing the cellar area and using hot air blowers also serve to minimize danger of freezing during winter operations.

**3.** Rolling casing from rack to walk. Caution should be exercised to avoid mashed toes or fingers.

**4.** Bringing casing through "V" door. When catline is used, care should be taken that joint does not "ram" someone on walk or rig floor.

**5.** Unsafe pick-up line and sling. Lines soon become frayed. Pick-up elevators should be used.

**6.** Stabbing board breaking or falling, or a person being knocked off the

board by swinging blocks. Personnel should step back out of the danger area if the blocks are swinging.

**7.** Floors muddy or ice-covered are dangerous at all times. Non-skid materials should be installed at danger points. Some operators use a fibrous, absorbent type material.

**8.** Long hours resulting in men becoming fatigued and not as alert as they normally would be.

Prior to casing a hole, the drilling line and all tools should be inspected. Sufficient lines should be strung to the blocks to avoid overloads. Safe high-pressure lines and fittings should be used during cementing operations and a swage should be available at all times while running casing.

This swage, which screws into the open collar of the casing, has welded or screwed into it a short two-inch nipple to which, in turn, is attached a half-union. This half-union is to be connected to the half-union on the lower end of the rotary hose, the latter being disconnected at the gooseneck. By using the rotary hose, a twofold advantage is gained: (1) the swage may be used for filling the pipe to avoid creating a mess on the floor, and (2) it permits circulating mud into the hole immediately if the well starts to kick over. A fill-up line equipped with a half-union also may be used with the swage if the rotary hose is not employed.

Another factor to consider is that running casing is a change in the regular work procedure of the drilling crew. The crew, not being as familiar with this work as with their regular day-to-day duties, are more prone to accidents.

**Handling tubing.** Most of these hazards concerning casing jobs apply also to tubing jobs, but to a somewhat lesser degree. Tubing frequently is run or pulled while the hole is loaded with oil and, of course, this increases the danger of fire. The floor can become quite slippery when working with oil and should be hosed down regularly and kept as clean as possible.

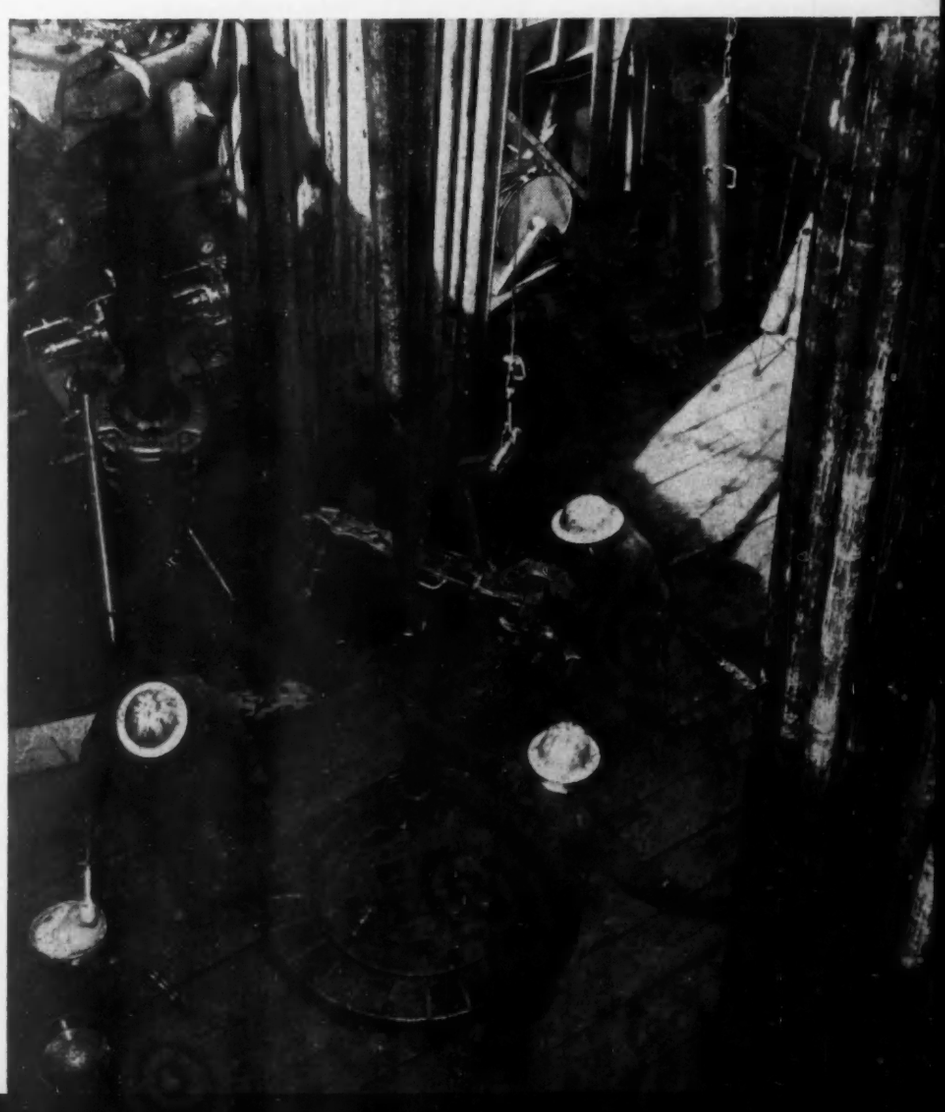
The proper size tools for the size tubing being handled always should be used. There is a common fault among rig crews to use pipe wrenches instead of tubing tongs and to use the cathead for breaking out or making up work, instead of using a swamp pipe or snipe. The use of wrenches is very dangerous as the wrench might slip or jump off the tubing and strike another man. Many injuries to arms and legs have been sustained in this manner. Using a rope from the end of a wrench to the cathead to break out tubing is also unsafe. The wrench often is not of sufficient strength to withstand the pull and may well break under the strain, with the possible result that the driller or cathead man may be struck with flying steel.

**Displacing with oil.** It is the practice of some operators to displace the fluid in the hole after the tubing has been landed and after the wellhead connections have been secured. This is done by using the rig pump. Drilling mud first is circulated out of the hole using fresh water. This has a washing or cleaning effect on the formation and casing. The fresh water is then circulated out by pumping oil into the hole. This cleans the entire hole and the well will more readily produce pipe line oil.

Crude oil must be hauled from the storage tanks by tank trucks to supply the rig pump. Extreme caution should be used in this operation. The oil should be pumped directly from the tank truck to the suction on the rig pump, and not dumped into an open pit to be picked up later. One fatality in Alberta's Redwater field was the direct result of a fire which occurred when a truck was being unloaded into an open pit. The tank on the truck blew up and the driver was fatally injured.

The wellhead assembly should be a completely closed system with a bleed-off line to the pit. As the fluid is lightened in the hole by displacing the heavier mud and water, some wells will start to flow without benefit of swabbing. The hook-up should be such that if a well "brings itself in," continuous flowing will be possible to the pit or stock tank. Of course, the

**Coming out of the hole in Western Canada. Care and proper tools will avoid delays and eliminate accidents.**



rule of no smoking or allowing open fires in the vicinity should be strictly enforced during a displacing job. Hydrogen sulfide gas may be present and gas masks should be provided for this emergency. Displacing is done occasionally at night and, while this is not good practice, it sometimes is necessary. When displacing at night it is good planning to always have two members of the crew working together so that, in case of a fire or gas accident, one man can help the other.

**Swabbing hazards.** More hazards exist when swabbing operations are in progress than can be elaborated upon at this time. One hazard, however, that can be mentioned, results when going into the hole too fast and having the swab tool strike gas pockets or fluid. This results in the throwing of a loop in the sand line. The line should be watched closely to avoid slack when running in.

Men should not stand too closely to the fast-moving drum when guiding the sand line. It is possible to have clothes fouled and pulled into the moving lines and machinery.

Particular care should be taken to guard against fire and smoking. Lights or open fires should be prohibited. If the oil saver does not work properly, or if the swab is popped out of the lubricator, the rig and equipment could be immediately covered with highly inflammable oil.

The lubricator should be of sufficient length to accommodate the swab and sinker bars. It should also be equipped with a valve at the bottom, close to the christmas tree. The lubricator itself should be snubbed with four lines to convenient points of the rig.

The sand line should be flagged, at the drum, at a point where the swab is 6 to 7 feet from entering the lubricator. This will enable the operator to have a warning as to when to slow down the travel. This will avoid popping the swab out of the lubricator, with resultant oil spray and fire hazard.

**Acidizing.** Acidizing is the most common remedial work that is done to make a well flow. Quite often, at completion, an acid wash or pressure treatment is all that is required. Sometimes the acid job is done while the drilling rig is still over the hole, while at other times a service rig is used. In either case, the hazards involved are the same. Before starting an acid job, all surface lines should be pressure tested in excess of the expected pressure required to inject acid into the formation. Serious injuries may occur from failure to take this precaution. In the event the lines leak under pressure while pumping acid, workmen might suffer bad acid burns. It is desirable to have plenty of fresh water available to wash eyes or skin in the event of an accident. Breakage of fittings or lines under pressure may also cause injury from flying steel.

The danger of fire from oil or gas while acidizing must be considered very carefully and fire extinguishers should be placed both at the wellhead and at the pump truck. No one should be allowed near the truck, lines, or wellhead, except when absolutely necessary. All visitors or workmen not actively engaged in this work should remain at a safe distance.

**Squeeze jobs.** A cementing job is one that must be done at extreme pressure and, in most cases, one that requires good supervision and great caution. Here again, as in acid work, all lines should be pressure tested before the job of squeezing is begun. On normal cementing jobs, the fluid in the hole should be mud or water. This fluid should have been circulated sufficiently to be gas free and to insure that there are no gas pockets in the annulus. This job should not be done with oil in the hole if it can possibly be avoided.

Bleed-off lines should be in place from the blowout preventers to the pit. The preventer rams should be closed while spotting the cement to the bottom and during the actual squeezing operation. With the rams closed and the bleed-off line open, all overflow or returns from the well will flow to the pit safely and the hazard of fire is virtually eliminated. Another safety point to remember is always to bleed off the pressure before tightening fittings when a leak has developed. Here again, men should avoid standing close to lines under high pressure except when absolutely necessary.

**Perforating.** Some wells are completed by setting the casing through the productive formation, cemented, then perforated, with crude oil being used to load the hole during the perforating operation. Use of crude often causes a slippery, messy condition around the well and the danger of fire as well as injury to personnel is, therefore, greater. Premature detonation of perforating guns on the surface is very remote since service companies are extremely careful in this operation. However, some operators require their personnel to remain a safe distance from the well during perforating or shooting operations, or at least while the guns are on the surface. There always is the possibility of the well coming in after being perforated. The gun should be pulled slowly from the hole to minimize swabbing action. A lubricator and stuffing box for the shooting line and gun always should be used. A bleed-off line also should be in place above the master gate.

**Hydrogen sulfide gas.** A great deal has been written and discussed on the subject of hydrogen sulfide gas. The principal hazard from this is poisoning by inhalation. This danger exists chiefly in cellars or under substructures on wells where there are possible accumulations of gas. Gas masks should be provided when its presence is anticipated. Where possible, cellars should be ventilated with blowers before crews enter. Rig employes should be familiar with first aid treatment for hydrogen sulfide gas poisoning. Maximum care should be taken to prevent escape of fumes into the air of working places. Before entering air suspected of containing hydrogen sulfide, a test should be made to determine whether or not the gas is present. No one should attempt to determine the presence of gas by its odor and no one should enter a tank, cellar or other enclosed place where gas has accumulated without wearing proper respiratory protection equipment and a safety belt secured to a life line held by another person outside.

There is no substitute for planning, proper tools for the job, and supervision. A big job lies ahead for supervisors: training all personnel in the practice of safety will eliminate accidents more effectively than any one thing that can be done by the industry today.

**ACKNOWLEDGMENT**

This article adapted from a paper originally presented by the author at the Third Annual Oilwell Drilling Safety Clinic, Canadian Association of Oilwell Drilling Contractors, Banff, Alberta, Canada, May 6-7, 1954.

—The End

# How Anchor Recovers 97% Of LPG Stored Underground

**Improved completion practices, surface handling, and storage techniques have enabled Anchor Petroleum Company to make exceptionally high recoveries.**

By **STUART G. BRANYAN**
Anchor Petroleum Company, Tulsa

WITHIN THE PAST few years underground salt cavern storage has progressed from an experimental undertaking to an accepted part of the petroleum industry. Special problems are associated with both salt dome and salt layer type storage, and local geological conditions tend to diversify underground storage problems further. Anchor Petroleum Company's three underground storage projects, including 11 storage caverns, located in Forrest County, Mississippi; Martin County, Texas; and Steuben County, New York, illustrate a variety of problems associated with both salt domes and salt layers.

**HATTIESBURG PLANT—FORREST COUNTY, MISSISSIPPI.** Anchor has completed two successful storage seasons at the Hattiesburg plant, which includes three wells drilled on the Petal salt dome. Figure 1a shows a geological section and illustrates a typical casing program. The loss of fluid zone near the top of the salt necessitated setting the main 9⅝-inch casing string into the salt and required a complete bond between the limited section of salt and the pipe. Special effort was directed toward a satisfactory primary cement job. In all wells, saturated brine mud was used to prevent hole enlargement, scratchers and centralizers were employed, and the last several hundred sacks of cement were mixed with saturated brine to prevent dissolving salt during dehydration.

Notwithstanding, at Well 1 a leak around the shoe was detected after drilling out the cement plug. Pressure employed on remedial squeeze jobs was limited to 600 pounds per square inch to prevent fracturing exposed salt. With this pressure limitation, six recementing jobs only partially shut off the leak. The seventh job, which consisted of resin cement, effected a complete shutoff. In the two subsequent wells, approximately 300 gallons of resin cement were placed near the casing shoe by displacement immediately after the main volume of cement. The same precautions mentioned above were employed in an effort to obtain satisfactory primary jobs. In one instance, a complete primary shutoff was obtained, but in the other, recementing was required. It is significant, however, that recementing of the third well was accomplished in two stages using resin cement.

Casing and tubing programs are illustrated in Figure 1a. The 7-inch casing is swung below the 9⅝-inch shoe to minimize washing behind the cemented casing. Use of 3½-inch outside diameter E.U.E. tubing was planned for all storage wells, but delay in delivery prompted use of 2⅞-inch tubing in Well 1 at Hattiesburg. Subsequent experience shows that the smaller tubing will plug more easily during washing and product injection and restricts the rate of product movement.

Leaching of Hattiesburg caverns was accomplished by pumping fresh water down the tubing and displacing brine out through annulus between the tubing and 7-inch casing. At the first two wells, the pumping rate was retarded to assure a high degree of saturation of the brine. In the third well, a propane blanket was injected into the annulus between 7-inch and 9⅝-inch casing. This procedure has proved more satisfactory since it permits more rapid leaching of the cavern and minimizes first year loss of product behind the 9⅝-inch casing.

Several precautions were taken to prevent breaking or plugging the tubing during periods of washing and product injections. Rubber diaphragm type desurgers and expansion joints have both proved helpful in eliminating tubing vibration. Salt crystalizing from saturated brine tends to plug the tubing. This action is prevented by periodic displacement of the tubing with fresh water. Insolubles from the salt will plug the tubing unless precautions are taken; and reverse circulation is established daily to carry out the fine insoluble matter at a high velocity through the tubing. Prior to injection of product, the tubing is raised a few feet as a further assurance against plugging with insolubles during the critical period of product injection and storage.

The casinghead is designed to permit pulling and running tubing under pressure. Such provision is particularly important in the event of tubing failure during the storage season. Mounting of the slips above the stripper rubber packoff is the most important feature of the assembly. This design permits removal of slips and movement of the tubing without disturbing the seal around the tubing. If necessary, an additional stripper rubber or blow out preventer can be installed on the flanged top.

**BADEN PLANT—MARTIN COUNTY, TEXAS.** Anchor's Baden underground storage plant has been expanded from three wells for the first storage season to six now being filled for the third year. A typical geological section and casing program are illustrated in Figure 1b. The entire salt section was cored at Well 1. Minor salt stringers were found to be interbedded with anhydrite and red beds above the main salt body. Several layers of anhydrite and numerous red bed inclusions were found within the main salt body.

Well completion was relatively simple since no porous strata were

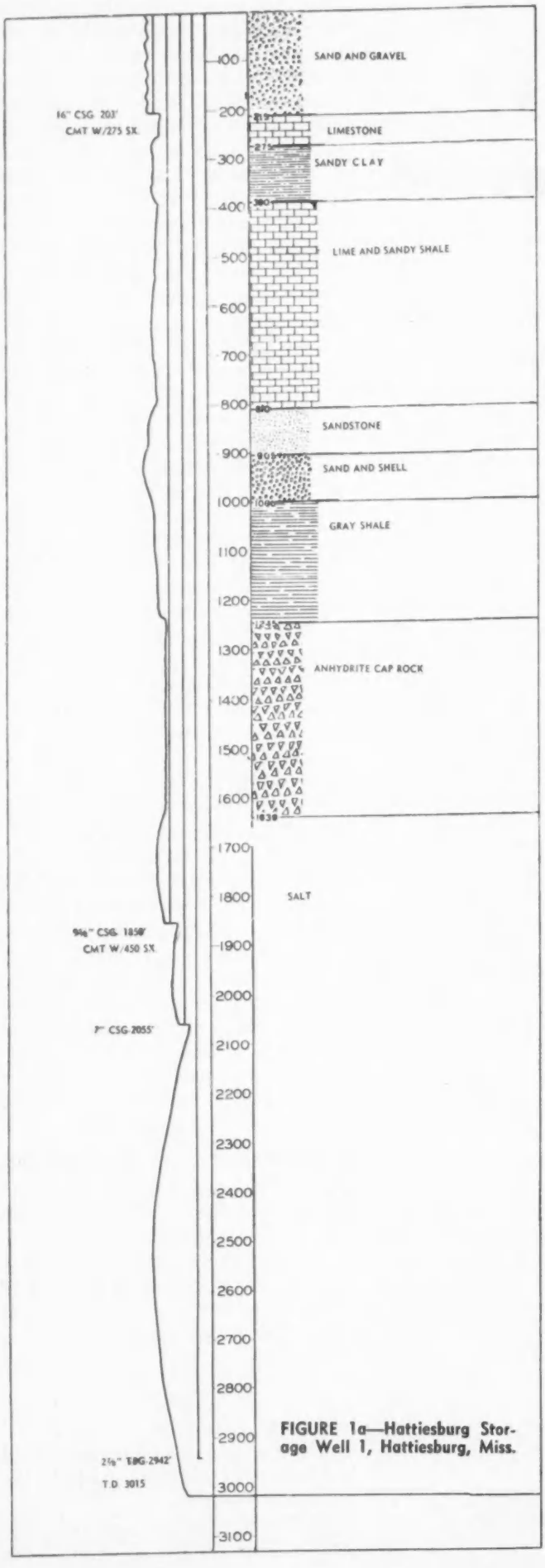



FIGURE 1a—Hattiesburg Storage Well 1, Hattiesburg, Miss.

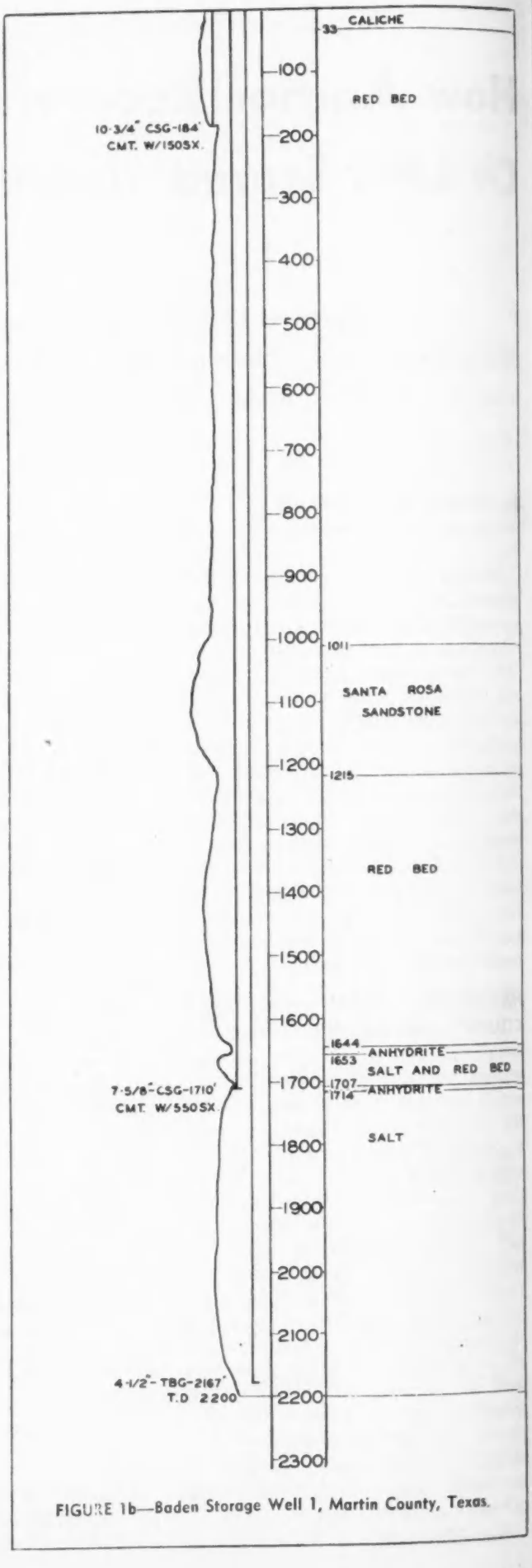



FIGURE 1b—Baden Storage Well 1, Martin County, Texas.

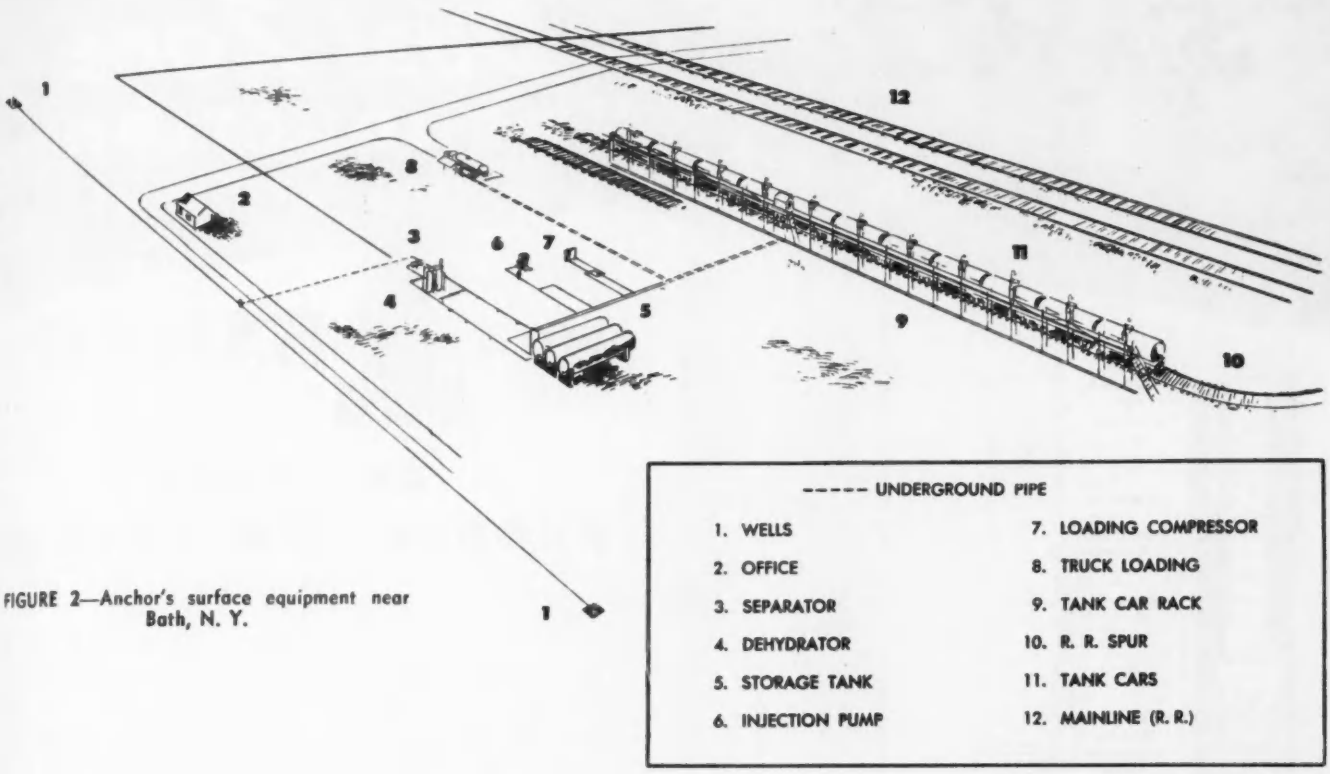



FIGURE 2—Anchor's surface equipment near Bath, N. Y.

found near the salt body. It is considered advisable to drill the salt with a minimum bit diameter of 9-inch so that tubing can be rerun through the insoluble anhydrite ledges, after the cavern has been washed out. The entire salt section was penetrated prior to running 7-inch or 7⅝-inch casing. A formation packer cementing shoe used was set opposite an anhydrite zone near the top of the main salt layer. This type cementing equipment protected the salt from the weight of the long cement column. Successful primary cement jobs were obtained at all six wells.

Because of the high percentage of insoluble material in the West Texas salt, 4½-inch tubing was used in the first well. Subsequent work proved that 3½-inch tubing is adequate, and this size has been used successfully on the other five wells. Washing has been accomplished by pumping fresh water down the tubing. Frequent reversals are necessary, however, to pump the insolubles out through the tubing at high velocity.

Similar precautions to those described for Hattiesburg are taken at the Baden plant to prevent tubing failure. Because of the simpler casing program, a more economical well head is employed on the Permian Basin wells, but the same basic features permit pulling and running tubing under pressure.

**BLAIR PLANT—STEUBEN COUNTY, NEW YORK.** Anchor has successfully completed a propane storage season in two salt caverns near Bath, N. Y. These caverns have since been enlarged, and product is being injected for the second storage season.

A 300-foot dense impervious limestone section logged immediately above Syracuse salt provides an ideal roof for the cavern and minimizes the chance of trapping product behind the casing. Cable tools were used for drilling both wells. By dressing the bit face to an angle of 75 degrees, chips were obtained which permitted satisfactory evaluation of the salt. The main Syracuse salt body was found to be clear crystaline salt until shale streaks were encountered near the base.

The ideal limestone roof permitted washing by reverse as well as conventional circulation. Half the washing has been in each direction in an effort to achieve near uniform diameter at the top and base of the caverns.

Well equipment is virtually identical to that described for the West Texas operation. Similar precaution was taken to prevent tubing damage.

**Surface Equipment.** Figure 2 is an illustration of Anchor's surface equipment near Bath, a 15-horsepower compressor is used to unload tank cars and transfer propane. An engine driven duplex pump is used to inject propane into the cavern. This pump had previously been used to wash the caverns, and was modified for 1100 psi product injection service by installing smaller liners.

Propane is recovered from the caverns by injecting water into the well tubing. Product passes out the well casing through a choking device to the free water knockout and filter device. Thence, it passes through a calcium chloride dehydration tower prior to loading tank cars, trucks or storage in surface vessels.

Dehydration equipment (Figure 3) is designed to handle propane at the rate of 250 gallons per minute. The free water knockout vessel included an excelsior type filter. An automatic water pump assembly is incorporated in the water leg. Since free water would rapidly dissipate the calcium chloride, an electric alarm has been

# Single Zone

# Dual Zone PRODUCTION

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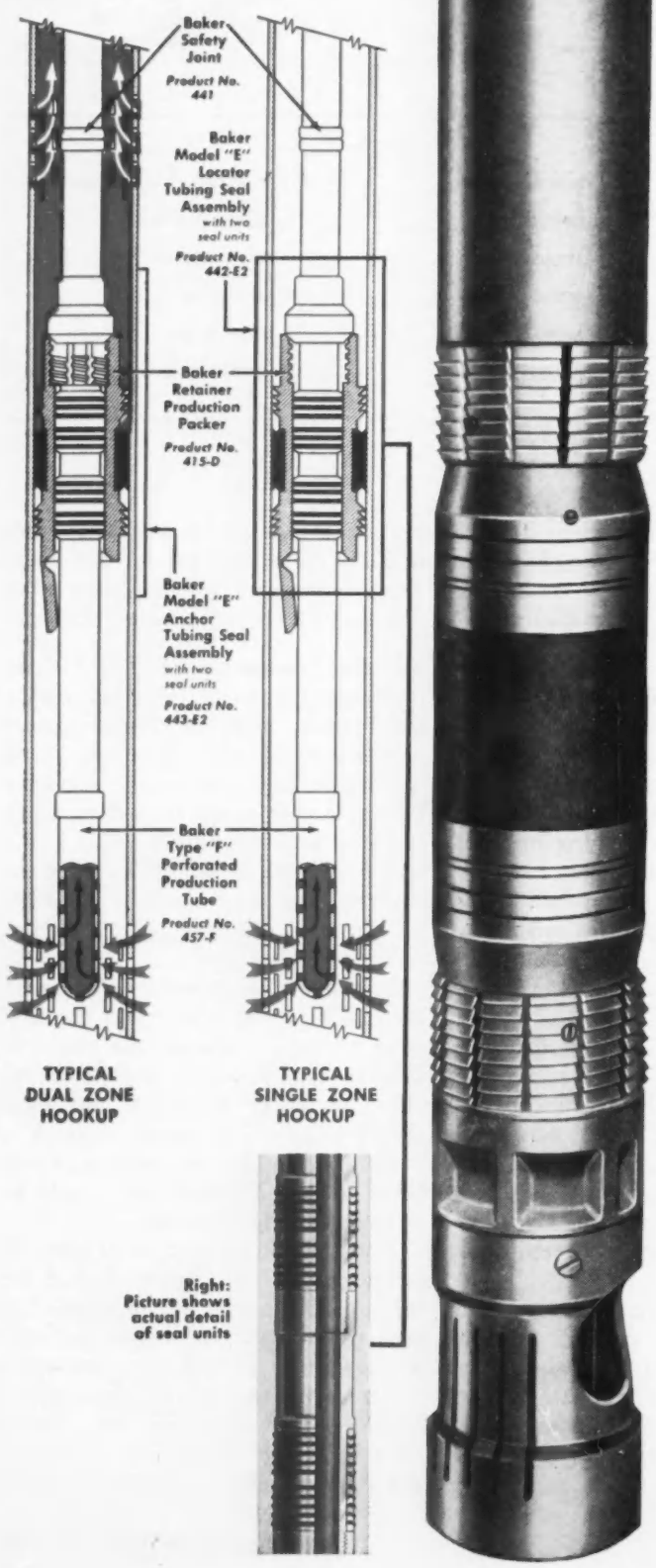
## RETAINER PRODUCTION PACKER


Baker Safety Joint
Product No. 441
Baker Model "E" Locator Tubing Seal Assembly with two seal units
Product No. 442-E2
Baker Retainer Production Packer
Product No. 415-D
Baker Model "E" Anchor Tubing Seal Assembly with two seal units
Product No. 443-E2
Baker Type "F" Perforated Production Tube
Product No. 457-F
TYPICAL DUAL ZONE HOOKUP
TYPICAL SINGLE ZONE HOOKUP



Right: Picture shows actual detail of seal units

Do you know that with only ONE Baker Retainer Production Packer you can equip your well for *either* SINGLE ZONE or DUAL ZONE production? And that you can accomplish *any* type of completion for *any* method of production to meet *fixed* or *changing* well conditions?

A single Baker Retainer Production Packer will also outperform many specialized tools when used as a TESTING PACKER – SQUEEZE PACKER – GAS LIFT PACKER – PERMANENT COMPLETION PACKER – WATER FLOOD PACKER – GAS INJECTION PACKER – CORROSION CONTROL PACKER – TUBING ANCHOR – ONE-WAY BRIDGE PLUG – PERMANENT BRIDGE PLUG.

*Every production man should be familiar with the many operating advantages of this "Universal Type" Packer, which include . . .*

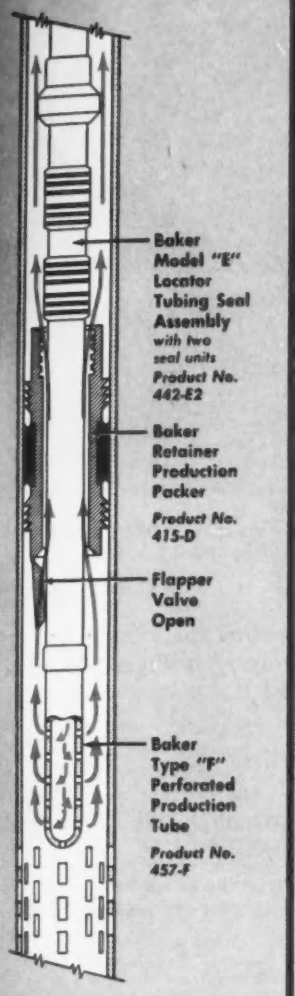
**WIRE LINE SETTING**—The packer can be set with *wire line speed and accuracy*, using the same set-up just used for perforating. The Baker Packer also can be set on drill pipe or tubing.

**SETTING UNDER HIGH PRESSURE**—By using a lubricator, the Baker Retainer Production Packer can be set under high pressure. From the moment it is set, the self-contained, flapper-type, back-pressure valve closes and isolates pressure below the packer.

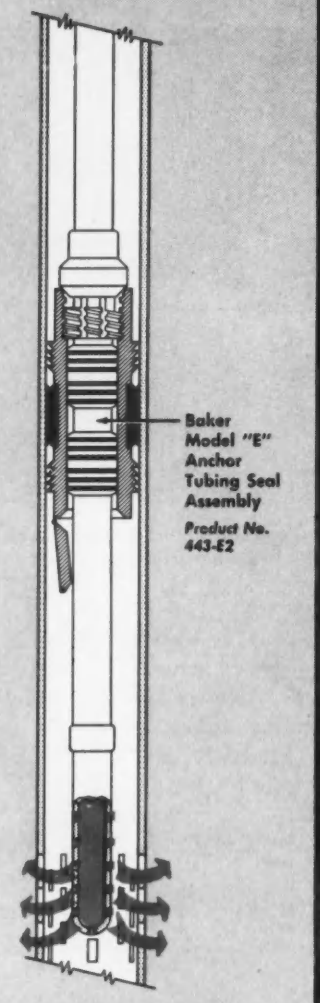
**TUBING STRING IS ALWAYS "FREE"**—That valuable string of tubing—whether 1,000 feet or 16,000 feet in length—can be removed by simply picking up the tubing weight.

**EXCESSIVE "SET-DOWN" WEIGHT OR TENSION NOT REQUIRED**—Even when squeezing, formation fracturing, or producing at any depth under pressure; a perfect pack-off is maintained independent of excessive set-down weight, or tension.

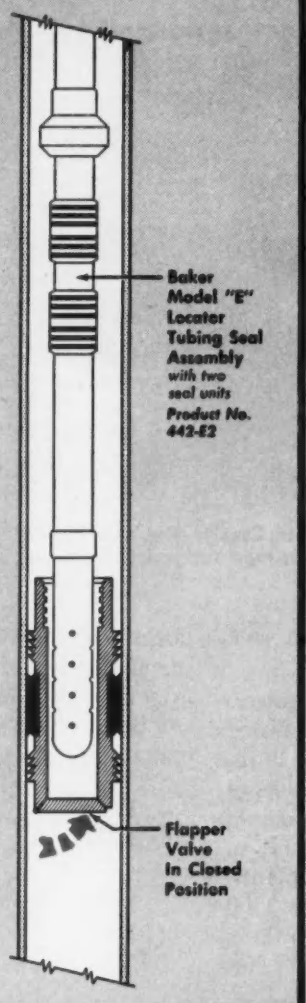
**HOLDS PRESSURE DIFFERENTIALS FROM ABOVE OR BELOW**—Two sets of opposed slips, and a resilient packing confined by lead and metallic sealing rings, effect a permanent pack-off that will hold any pressure differential *either from above or below the packer* that is safe for the well equipment.


Baker Model "E" Locator Tubing Seal Assembly with two seal units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Flapper Valve Open
Baker Type "F" Perforated Production Tube Product No. 457-F

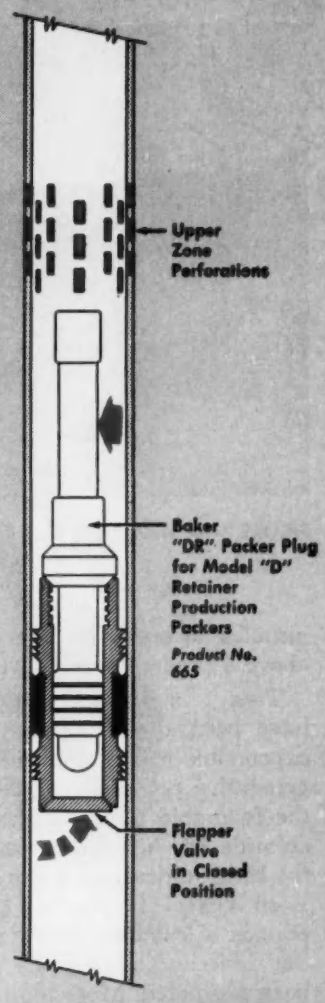
**Washing or Circulating**—Seals of Locator Tubing Seal Assembly removed from packer bore. Flapper Valve held open by tubing extending below the Packer.




**Pressuring Below Packer**—Acid or cement squeeze, formation fracture, gas or water injection. Anchor Tubing Seal Assembly is used when high squeeze pressures are required.




**Isolate Zone Below Packer**—Tubing String removed, Flapper Valve closed. Isolates pressure differentials (squeeze, production) from below the packer.


Upper Zone Perforations
Baker "DR" Packer Plug for Model "D" Retainer Production Packers Product No. 665
Flapper Valve in Closed Position

**Temporary Bridge Plug**—For working over zones above the packer. DR Plug is run in on Baker Retrievable Cementer and retrieved with overshot.

PACKS-OFF AND HOLDS UNDER HIGH BHT—Baker Retainer Production Packers will hold high pressures under conditions of high temperatures. Hundreds of Baker Packers are in successful service in Southwest and Gulf Coast areas where temperatures in excess of 300 degrees are not uncommon.

RESISTS CORROSION—The cast-iron used in the construction of Baker Packers is far more resistant to corrosion than the casing in which the packer is set, thus making it ideal for permanent installations, or for use in areas plagued with a severe corrosion problem.

EASILY DRILLABLE—The Baker Packer is constructed of drillable cast-iron, and its design supplements the breaking-up action of the bit. Whether it has been in the well for only a few hours, or for ten years, the Baker Packer can be drilled up in minimum time. Expensive and hazardous "milling-out" operations never are required.

## IMPORTANT FACTS

Baker Packers are used in a majority of installations where conditions of extreme pressure, temperature, or depth are present. Baker Packers also dominate Dual Zone installations, particularly those involving two-packer, crossed-flow arrangements.

BUT IT IS ALSO TRUE that *more* Baker Packers are used for *simple single zone* completions than for *any other type of completion,* and that *most* Baker Dual Zone installations employ *only one* packer.

*Ask any Baker representative, or office, for complete details. There is no charge, and no obligation, for specific recommendations and completion planning advice available from Baker Technical Advisers. Why not be prepared for your next completion?*

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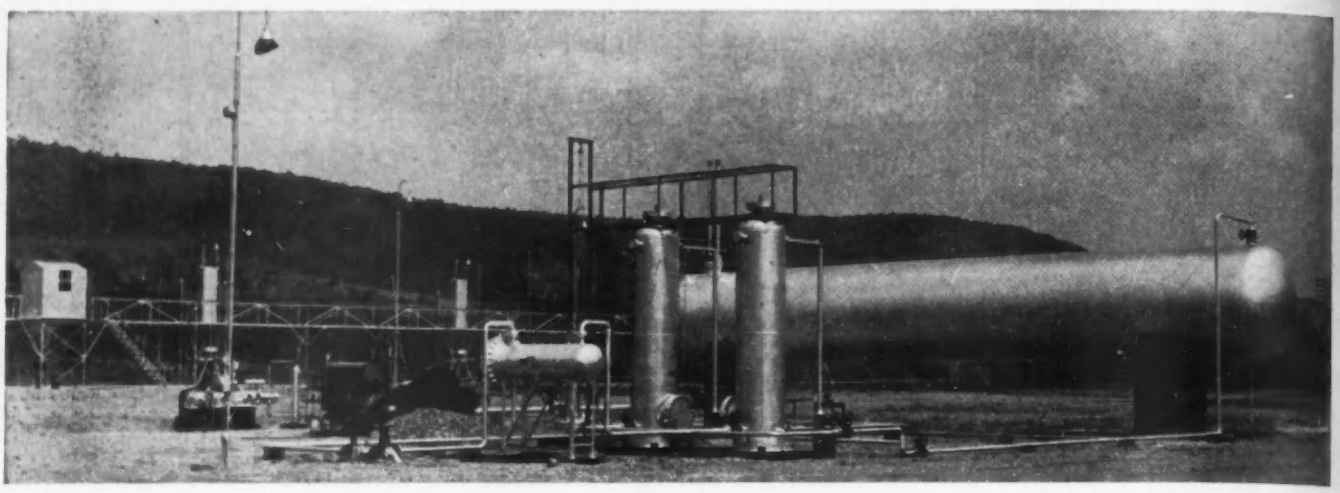

FIGURE 3—A view of the Blair (Steuben County, New York) storage plant. Two vertical dehydration towers are shown in center. Ladder and scaffolding permits rapid recharging. Free water separator and filter is located immediately to the left.

installed to operate if the water rises above a predetermined level.

Two 3 x 10-foot vertical towers have been designed to use either expendable calcium chloride or a regenerative type desiccant. Because of the favorable result to date, calcium chloride has been used exclusively in the three underground storage plants. Each vessel is packed with 2500 pounds of calcium chloride. To date, the desiccant in only one vessel has been dissipated. More than 15 million gallons had been processed prior to this failure, indicating a handling capacity of 6000 gallons per pound. This figure is tentative since the unit failed due to channeling of fluid when the calcium chloride was only partially expanded. Improved results should be expected if current efforts to minimize channeling are effective. Most significant is the fact that the calcium chloride depresses the dew-point of propane to —38° F. This compares most favorably with —15° F. which is a commercially acceptable standard for propane.

The surface equipment layout at the Baden and Hattiesburg plants is similar but more extensive. Both of these plants handle two products i.e. propane and butane or propane and a mixture. For that reason, the equipment is duplicated for simultaneous handling of two products.

**Cavern Diameter from Equilibrium Pressure.** Shape and diameter of salt caverns is a matter of importance to underground storage operators. Several logging services are available for the purpose, but these require pulling of the tubing for the survey. Equilibrium pressure data have been used to calculate average cavern diameters in several Anchor wells. This is accomplished by suspending injection operations at given intervals and carefully bleeding the tubing pressure to zero. Referring to Figure 4, it will be recognized that:

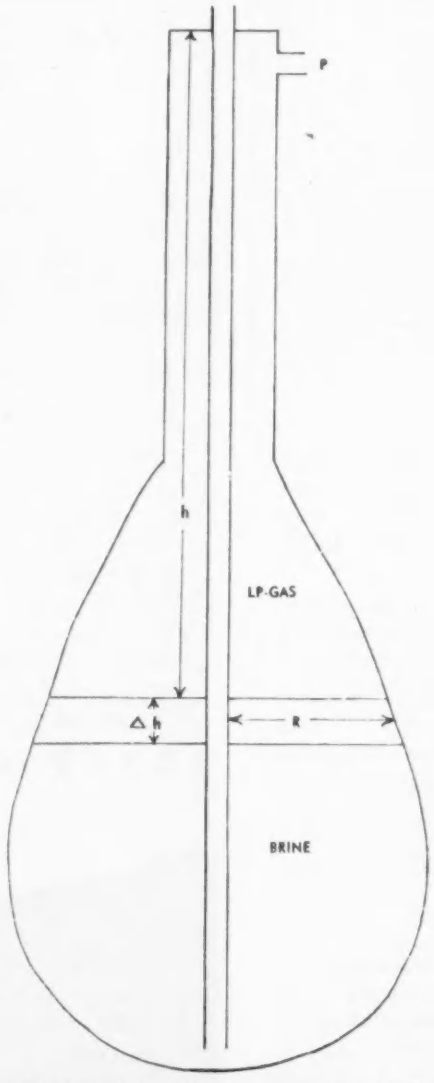


FIGURE 4—A simplified view of a salt storage well.

$$(1)\quad h = \frac{P}{0.434\,(d_B - d_p)}$$

Where:

$h$ = depth to the LP gas-brine contact, feet
$P$ = casing pressure — psi
$d_B$ = specific gravity of brine
$d_p$ = specific gravity of LP gas

Or:

$$(2)\quad \Delta h = \frac{\Delta P}{0.434\,(d_B - d_p)}$$

for the incremental part of the cavern. Then average cavern radius for that part of the cavern can be calculated for any interval by,

$$(3)\quad R = 0.206\sqrt{\frac{\Delta g}{\Delta h}}$$

Where:

$\Delta h$ = vertical height filled during interval, feet
$\Delta g$ = gallons LP gas injected for interval
$\Delta R$ = average cavern radius for internal, feet

Figure 5 shows typical cross-section that has been calculated for a Petal Dome storage cavern. Basic data recorded for this work are tabulated below:

| Pressure —P | Cum. Gallons Injected | Average Radius—R |
|---|---|---|
| 665 | 0 | |
| 710 | 487,495 | 11.9 |
| 738 | 778,071 | 11.6 |
| 798 | 1,528,915 | 12.8 |
| 822 | 1,805,149 | 12.3 |
| 845 | 2,334,801 | 17.4 |
| 854 | 2,706,139 | 23.2 |
| 873 | 3,492,536 | 23.4 |
| 887 | 3,919,818 | 20.1 |
| 896 | 4,074,170 | 15.0 |
| 914 | 4,334,355 | 13.8 |

Reliability of the method is dependent upon accurate pressure meth-

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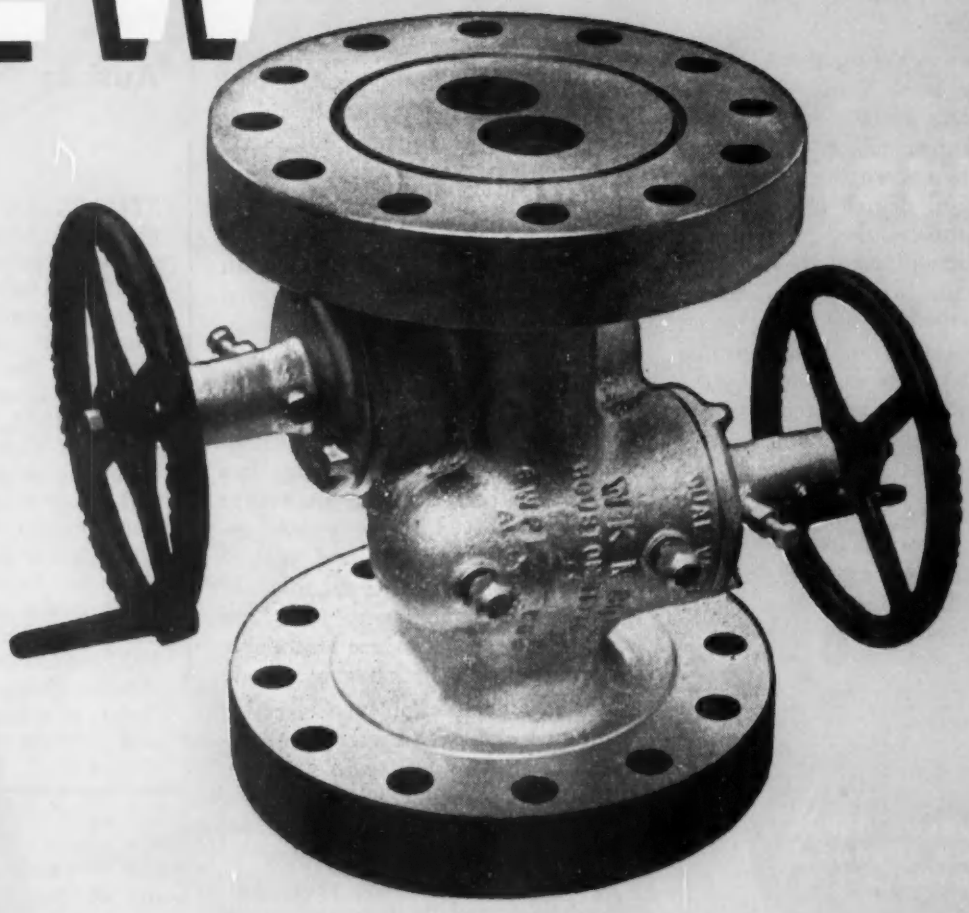

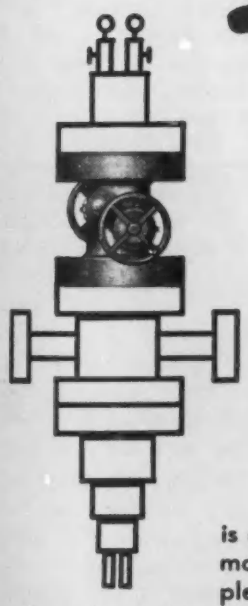

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ods. For that reason, the gages should be frequently calibrated with a dead weight tester. A good check on the method can be obtained at the beginning and end of the cavern filling cycle since "h" values are determined at these times by casing and tubing measurements.

The cavern in Figure 4 was formed by pumping fresh water down the tubing. In this method of leaching, minimum diameter is expected near the top of the cavern since the water reaches a high degree of saturation before it contacts this part of the salt. Maximum diameter is found an appreciable distance above the base of the cavern. This condition seems to be typical for the type washing employed. It can be explained by the fact that the fresh water tends to rise vertically through more dense brine as it first enters the cavern from the tubing.

**Recovery.** Favorable recovery from salt cavern storage is reported throughout the industry. During the past storage season, Anchor Petroleum Company's nine wells yielded 97.3 percent recovery for the 25 million gallons stored. It is significant that three wells in their initial storage season, when losses are greatest, are included. Losses of this magnitude can be explained as above ground handling loss and trapping of production in newly formed pockets of the caverns. Such an opinion is supported by careful hydrostatic tests conducted after emptying each cavern.

Comparative data on first and second year recoveries for 10 Permian Basin storage caverns are presented in Table 1. During the first season, losses ranged from 4.1 to 13.1 percent and averaged 8.7 percent of the injected volumes. During the second storage season, the same group of wells experienced an average loss of only 3.3 percent. It is important that an improved recovery was experienced during the second year in all instances. Of further significance is the fact that first year losses are erratic, but recoveries are reasonably consistent during the following season.

Varying completion and washing techniques employed by the operators probably explain the wide variation in first season recoveries. Uses of an auxiliary washing string is an effective method of minimizing trapping of product during the first year. This procedure materially increases storage investment and in the case of salt layer caverns, the choice is economic. Additional completion costs must be balanced against first season loss of product.

**Industry Progress.** Remarkable progress has been made in the technique of underground salt storage in the few years since its inception. Some of the earlier efforts were marked with mechanical difficulties and serious loss of product. Breaking, unscrewing, and plugging of tubing string was probably the most serious early problem. Such difficulties have been reduced to only an occasional failure throughout the industry. Improved completion, washing, and testing procedures now assure a favorable recovery on properly planned projects.

Perhaps the most important progress has been in the training of personnel. Development and operation of underground storage requires a background in well completion and handling, in plant experience; and, in addition, presents specialized problems not found in other phases of the petroleum industry. Out of necessity, a group of experienced underground storage supervisors and workers have evolved. This on-the-job training is probably the most important factor in the present success of underground storage. A continuation of the trend should yield important progress in the future. —The End

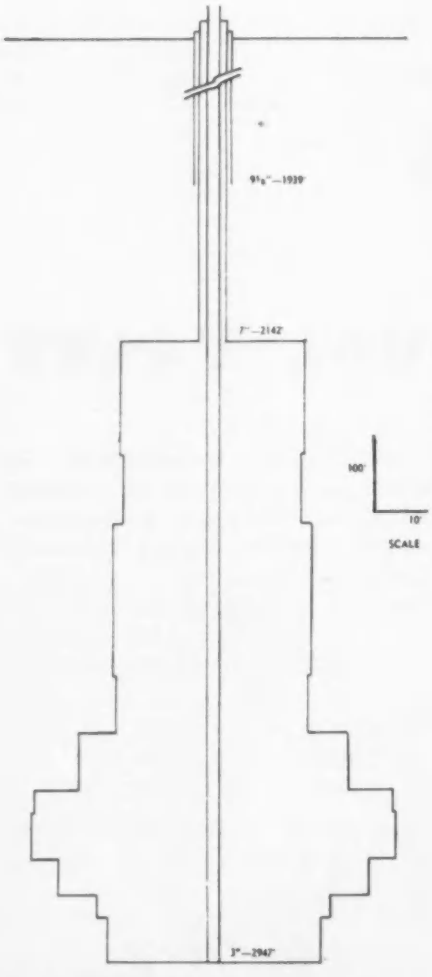


FIGURE 5—Average cavern diameters as determined for equilibrium pressure calculations.

**TABLE 1**

**Recovery Data**
**Storage of LPG in Salt Caverns**
**Permian Basin-West Texas and New Mexico**

| WELL | FIRST YEAR | | SECOND YEAR | |
|---|---|---|---|---|
| | Barrels Stored | Loss Percent | Barrels Stored | Loss Percent |
| 1..... | 28,610 | 5.4 | 41,376 | 4.0 |
| 2..... | 33,457 | 10.9 | 52,289 | 0.7 |
| 3..... | 26,121 | 7.0 | 41,600 | 4.3 |
| 4..... | 35,100 | 4.0 | 38,800 | 3.0 |
| 5..... | 30,300 | 5.2 | 35,200 | 3.2 |
| 6..... | 74,952 | 4.1 | 90,500 | 3.1 |
| 7..... | 30,000 | 13.0 | 58,824 | 5.0 |
| 8, 9, 10..... | 120,000 | 13.1 | 194,000 | 3.3 |
| Totals and Averages | 378,540 | 8.7 | 552,589 | 3.3 |

## About the Author

STUART G. BRANYAN was graduated from Lehigh University with an engineering degree in 1937. During the subsequent year, he completed a student engineering program with Westinghouse Electric and Manufacturing Company. From 1938 to June 1952, he was associated with The Carter Oil Company, beginning as an attached helper and progressing through successive petroleum engineering assignments to district engineer. In the latter capacity, he served in Kansas, the Arkansas-Louisiana area, and Oklahoma. Since June 1952, he has been associated with Anchor Petroleum Company, in Tulsa, as manager of Production and Underground Storage.

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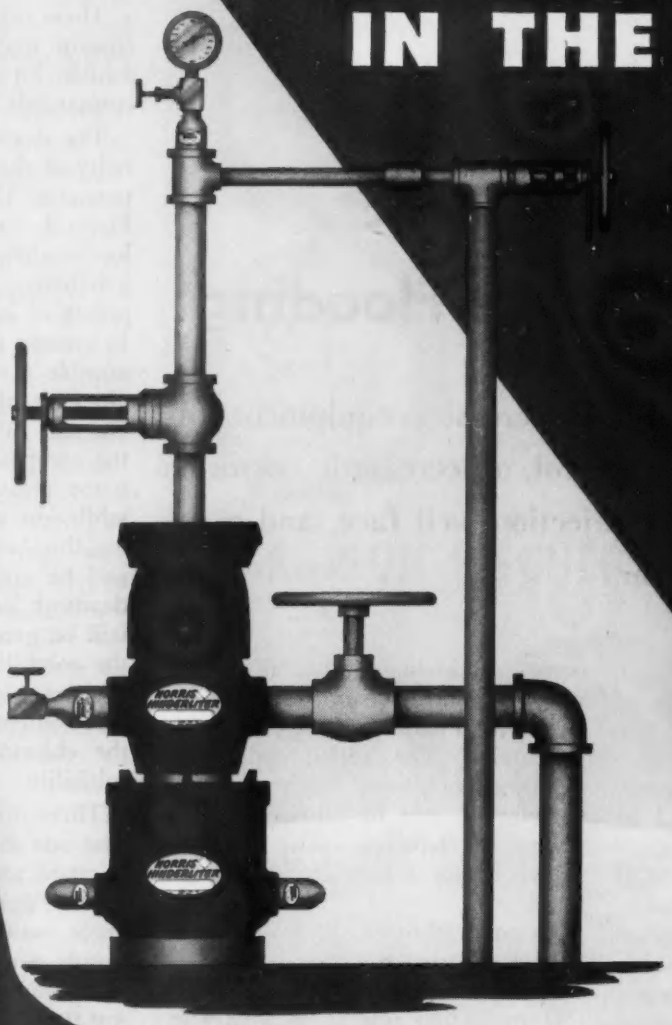

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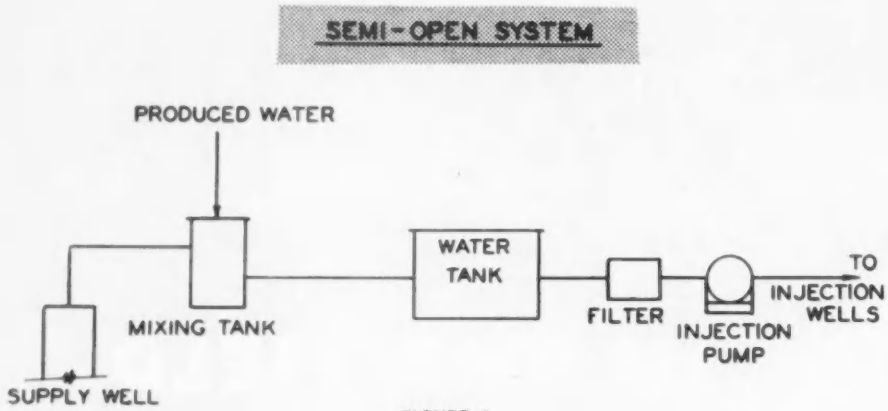



FIGURE 1

# Application of Organic Inhibitors in Water-Flooding

**—has resulted in a decrease in equipment corrosion, improved bacteria control, a decrease in corrosion products deposited on the injection well face, and a decrease in interfacial tension.**

**By J. B. ROBINSON**
Tretolite Company
Tulsa

WATER SOLUBLE, semi-polar, organic inhibitors have proved successful in combating corrosion on both production and input systems of water-flood units. The proper selection of testing and control points as well as treatment stations will insure proper control over project and guarantee better results. Concrete rules for inhibiting corrosion cannot be established, but there are some tried-and-proved methods that might aid the operator in selecting the best method for combating his particular problem.

Corrosion of varying degrees can be expected in practically all water-flooding operations. This attack is caused normally by dissolved gases, such as carbon dioxide, hydrogen sulfide and oxygen. The corrosion attack can occur practically at any place in the system or throughout the entire system. Corrosion is detrimental for obvious reasons, such as decreased life of equipment. A secondary effect, which is not usually realized, is the plugging of injection wells by the corrosion products. This, of course, results in a decrease of water injection rates with a corresponding decrease in production. The added expense of acidizing and back flushing loss in production, cost of equipment replacement, have in many cases resulted in an economically unsound flood.

Organic inhibitors have come into widespread use in controlling corrosion on the injection side as well as the production side of secondary recovery units. The cost of treatment with these inhibitors is insignificant when one considers the direct, as well as indirect, benefits derived from their use. It might be well to mention here that since practically all good organic inhibitors decrease interfacial tension, higher injection rates can occur from this fact alone. This will be demonstrated in a future illustration.

The normal treating costs for treatment of injection water with these inhibitors will vary from flood to flood dependent upon the corrosiveness encountered. Generally, however, the concentration of inhibitor required is usually between 10 and 15 parts per million. Based on these concentrations, the treating cost will vary from .8 to 1.2 mils per barrel of water injected. These figures ignore the initial slugging period required at the outset of the treatment.

In the selection of an inhibitor for any particular system, a number of factors must be considered. Among these are toxicity, solubility, ease of handling, and other physical characteristics.

These organic inhibitors under discussion may be described as water soluble liquid, semi-polar, organic compounds.

The degree of water or brine solubility of the inhibitor is of prime importance. This is true for two reasons. First, if the compound has poor or low solubility, it is possible to lose the inhibitor through filtration or at points of low velocity in the system. In systems that contain no filters, it is possible for the inhibitor to cause plugging of the injection formation. On the other hand, if solubility of the compound in the injection water is too great, the chances are that the inhibition will be poor. The reason for this being that the film stability will be greatly reduced, or that the deadsorbtion rate of the inhibitor film will be greatly increased. In general, the solubility of these organic inhibitors is dependent upon the chloride content of the water. The higher the chloride content, the lower the solubility.

There are a number of precautions that one should observe in the treatment of any water-flood system with organic inhibitors. Of prime importance, when one is treating a water supply well which employs a deep well pump, is the necessity of circulating the well until at least three complete cycles have been made. These supply wells usually have a high static level and circulation is the only means of getting the inhibitor around.

There are a number of methods for treatment of water-flood systems with organic inhibitors. These methods include batch treatment, continuous treatment, and combinations thereof.

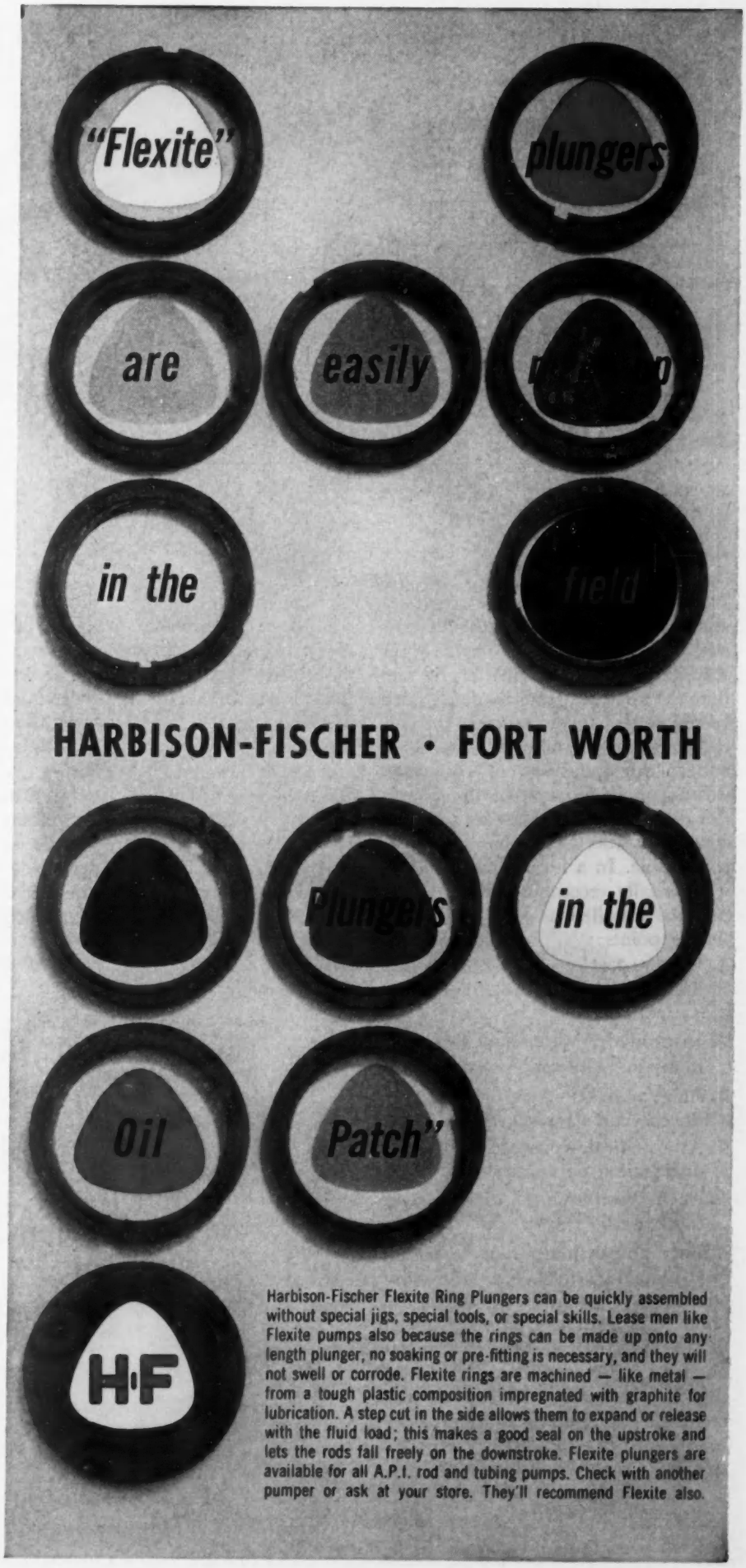
Batch treatment is used on most supply wells where submerged pumps are installed. Normally a pouring inlet is attached to the well head into which a flush line from the tubing is connected. The inhibitor is mixed with water prior to the injection or simply dumped into the annular space

and flushed with copious quantities of water. After the circulating procedure the well is then returned to normal operation. General practice in the field at present is to treat supply wells daily. However, it is quite possible that treatment two to three times per week may suffice, as this has been found true in treating producing wells. Since most water-floods operate with positive pressure, continuous injection in other parts of the system is necessarily accomplished by means of a chemical proportioning pump.

To successfully inhibit any flood, the selection of proper chemical injection points is of utmost importance. Normally, injection should be made as far back in the system as possible. In other words, treatment should be initiated at the supply well or in the flow line close to the water supply. Treatment of the produced water that is to be injected along with the supply water should be made as close to the water collecting stations as is feasible. Treatment of the system in this manner will afford protection to all the equipment at a minimum cost. The injection points, however, may vary considerably from system to system depending upon the physical and mechanical setups involved. For example, in a system that utilizes an aerating tower for the removal of hydrogen sulfide or iron, treatment should be made at the discharge of the settling pond. The normal recommended treating procedure is as follows:

1. For the first three days, slug the system with an inhibitor concentration of 50 parts per million. This is necessary in order to insure the complete coating of the internal surfaces of the equipment with the inhibitor protective film.
2. For the next three day period, treatment should be reduced to a concentration of 20 ppm.
3. Subsequent treatment is normally in the range of 10 to 15 ppm, however, the minimum treating rate is usually determined by the use of control methods, which will be described.

The most generally accepted means for determining the results to be expected from the use of an organic inhibitor and the determination of the minimum required treating ratio is through the use of corrosion test coupons installed at various points throughout the system. There are a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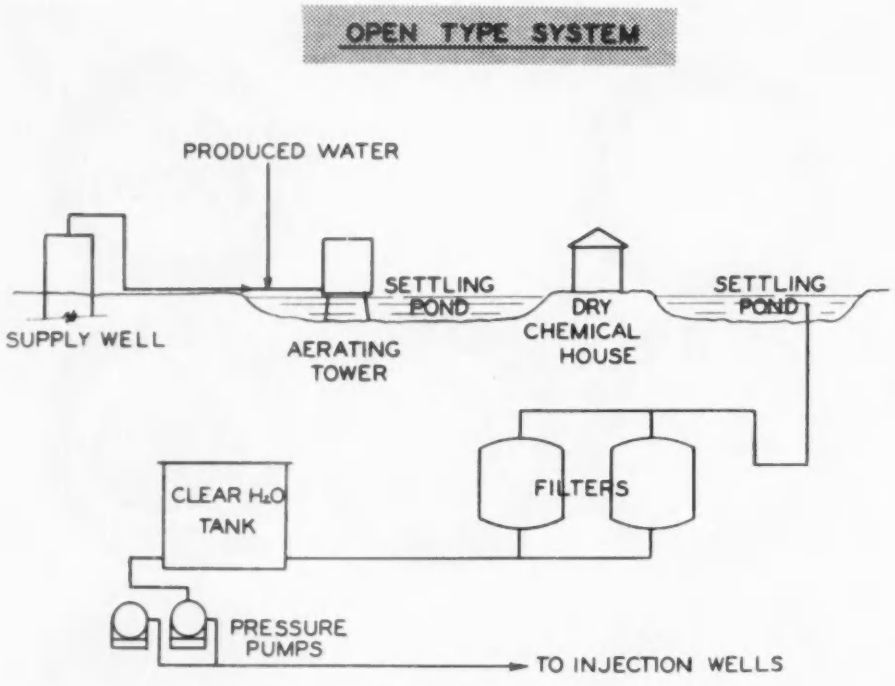


FIGURE 2

number of factors that must be realized when test coupons are used. Probably of prime importance is the fact that the corrosion rate as determined by test coupons only indicates the corrosion rate at the point of installation and is not indicative of conditions existing in other parts of the system. For this reason it is necessary to locate corrosion stations at as many points as practicable. In a normal flood set up, it is usually recommended that coupons be installed at least at the following points:

1. Wellhead of supply well or in flow line close to the supply water source.
2. In produced water flow line prior to mixing with supply water.
3. At a point after supply and produced waters are mixed.
4. At a point downstream of filters or at injection pump intake.
5. At the wellhead of one or more input wells.

Since the coupons have a freshly sand-blasted surface, they are more conducive to corrosion whereas the flood equipment has the tendency to be pacified. However, the results obtained can be considered to be relative. In other words, if prior to treatment the test coupons indicate a corrosion rate of 10 MPY[1] and after treatment a corrosion rate of 1 MPY, it is safe to assume that the system is being protected to a degree of 90 percent even though corrosion of the equipment is probably of somewhat lower magnitude. Experience reveals that if the corrosion rate, as determined by test coupons, exceeds 4 MPY, the system under consideration should be treated with an inhibitor.

Another accepted method for determining the severity of corrosion in the system is through the determination of iron content of the water at various points. Through water analysis, it is possible to calculate the actual pounds of iron lost between any two points in the system per unit of time. However, the use of test coupons is more reliable since a very small change in iron content may represent a great change in corrosion rate.

To demonstrate the significance of the points covered, a short history of several floods will be discussed:

**FLOOD A.** This system may be described as a semi-open type installation (Figure 1). The supply water is obtained from the Arbuckle formation by means of a deep well pump. This water contains considerable quantities of carbon dioxide. At the start, the supply well was treated with a water soluble organic inhibitor at a concentration of 10 ppm as an insurance measure since test coupons through the system showed that a low corrosion rate existed.

After fill up, the percentage of water in the producing wells increased, and it became necessary to add produced water to the supply water. The corrosion rate, as determined by test coupons and by line leaks, etc., rose rapidly. As a matter of fact, the corrosion rate throughout the system increased directly with the increase in produced water. This phenomenon was due to one of two reasons. (1) Dilution of the inhibitor concentration, or, (2) the corrosiveness of the produced water, or a combination thereof.

As the corrosion rate increased it became evident that the treatment of the produced water was mandatory. Continuous injection of an organic inhibitor was initiated as a concentration of 20 ppm at the discharge of the various field accumulators. This treat-

**TABLE 1**
**Flood B**

| Well No. | *Input Average May | †June 30 | July 7 | July 15 | July 21 | July 29 | Aug. 16 | Aug. 31 | Sept. 14 | Sept. 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 20 | 25 | 31 | 30 | 28 | 28 | 28 | 28 | 29 | 31 |
| 20 | 42 | 48 | 50 | 45 | 44 | 42 | 40 | 41 | 40 | 46 |
| 34 | 7 | 10 | 10 | 10 | 10 | 6 | 5 | 5 | 4 | 4 |
| 35 | 40 | 67 | 67 | 63 | 67 | 66 | 63 | 66 | 68 | 71 |
| 36 | 61 | 57 | 62 | 40 | 79 | 74 | 67 | 71 | 99 | 84 |
| 37 | 54 | 55 | 65 | 50 | 49 | 49 | 47 | 50 | 47 | 50 |
| 38 | 114 | No Record | No Record | No Record | No Record | No Record | 218 | 153 | 134 | 126 |
| 40 | 7 | 7 | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 7 |
| 43 | 12 | 13 | 11 | 10 | 10 | 8 | 8 | 9 | 7 | 7 |
| 44 | 33 | 32 | 34 | 31 | 33 | 35 | 34 | 39 | 34 | 33 |
| 51 | 37 | 66 | 62 | 38 | 56 | 57 | 61 | 65 | 77 | 83 |
| 52 | 19 | 41 | 42 | 38 | 38 | 39 | 40 | 41 | 23 | 21 |
| 53 | 29 | 37 | 37 | 34 | 34 | 35 | 37 | 40 | 39 | 40 |
| 54 | 43 | No Record | No Record | 49 | 49 | 50 | 50 | 50 | 49 | 53 |
| 55 | 35 | 46 | 43 | 33 | 37 | 38 | 31 | 34 | 40 | 45 |
| 57 | 84 | 82 | 86 | 78 | 84 | 80 | 95 | 96 | 109 | 122 |
| 58 | 13 | No Record | 15 | 13 | 13 | 13 | 17 | 16 | 16 | 14 |
| 59 | 16 | 25 | 25 | No Record | 18 | 18 | 20 | 20 | 19 | 22 |
| 60 | 26 | 37 | 38 | 31 | 34 | 35 | 38 | 36 | 41 | 46 |
| 39 | 36 | 40 | 40 | 35 | 37 | 37 | 38 | 39 | 40 | 45 |
| Total | 728 | 688 | 726 | 636 | 727 | 717 | 944 | 906 | 922 | 950 |

* No Inhibitor Added.
† Inhibitor Added from June thru Sept.
Average Input Increase from June thru Sept.—22.5 percent
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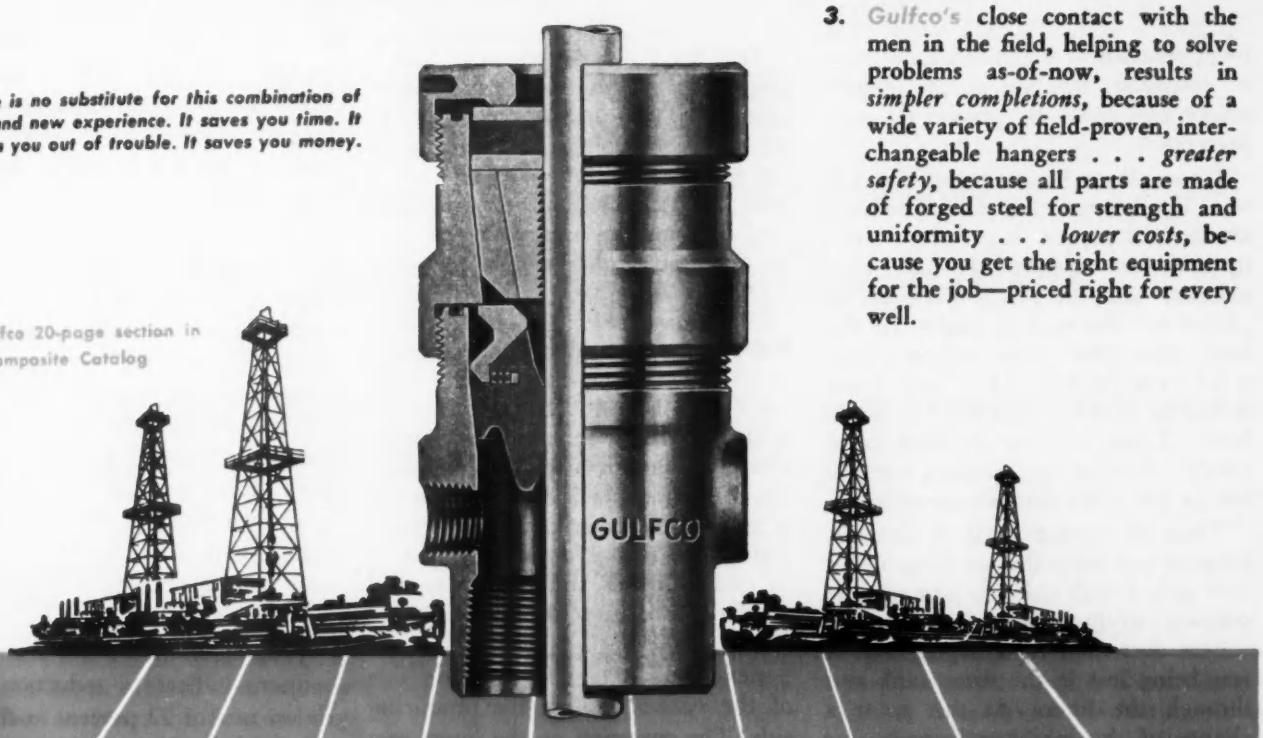


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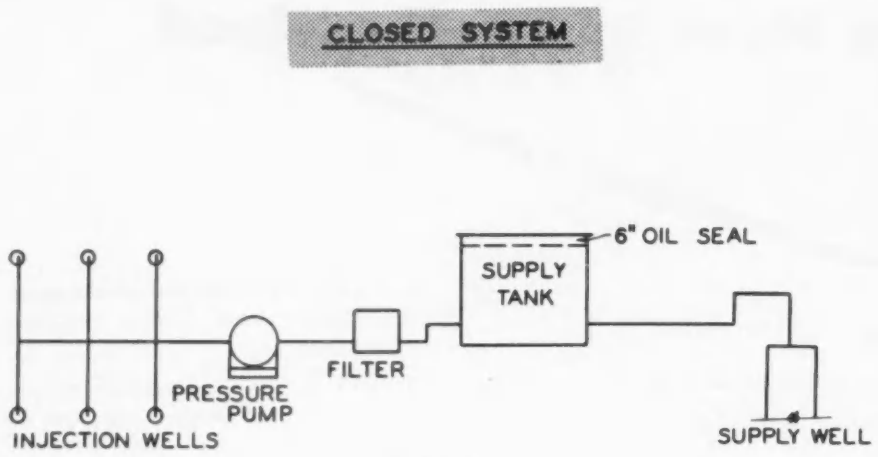



FIGURE 3

ment resulted in a significant decrease in corrosion, but not to the degree where one could be certain of good protection.

Upon closer inspection of the system, it appeared that considerable amounts of oxygen were being picked up in the accumulators. It was recommended that a 6-inch oil seal be placed on the various tanks. At the same time, the water delivery lines were extended so that the water would be introduced below the liquid level. These changes resulted in a further decrease in corrosion, but still not to the point that was desired.

Through further study it was discovered that since the produced water had such a high chloride content, the solubility of the inhibitor in the mixed waters decreased to a degree that it was being lost in the surge tank and through the filters. At this point a change of the inhibitor formula was made. The inhibitor recommended, although of the same chemical family as the one previously used, demonstrated better brine solubility. This change, incorporated with all the mechanical changes, has resulted in outstanding protection of the system.

This flood was discussed because a number of unusual circumstances arose. We feel that it points out to the corrosion engineer that there is no cut and dried solution to any problem and that constant experimentation is usually necessary to arrive at an acceptable solution to a corrosion problem.

**FLOOD B.** This flood may be described as an open type system (Figure 2 and Table 1). The supply water is obtained from the Arbuckle formation and contains considerable quantities of hydrogen sulfide. Supply water is aerated in order to remove hydrogen sulfide and iron and, thence, treated with lime and alum to control alkylinity and flocculate precipitates.

Relatively severe corrosion was experienced both on the injection side of the system and on the producing side. The corrosion on the input part of the system was traced to both normal corrosive action and bacteria attack. On this basis it was concluded that a water soluble organic inhibitor should be used to control both factors. It was also felt by the operators that the injection wells were not taking the proper amount of water, undoubtedly because of partial plugging of the sand face by corrosion products.

Shortly after the injection of the inhibitor to the input water the input rates on the system increased. The increase in injection is undoubtedly due to three reasons: (1) A decrease in interfacial tension, (2) Improved bacteria control, and, (3) A decrease in corrosion on the injection side with a corresponding decrease in corrosion products deposited on the injection face. Over-all, an increase of 22½ percent in injection rates has been realized.

**FLOOD C.** This flood, handling Arbuckle water, is located in Oklahoma. This system is an entirely closed system (Figure 3 and Table 2). The water is filtered and the only treatment is with sodium hexametaphosphate for the stabilization of calcium scaling tendencies and the use of an organic inhibitor for prevention of corrosion and bacteria. Coupons were placed in one of the water supply wells pumping approximately 6600 barrels of Arbuckle water daily. Coupons were also placed in two injection wells each handling approximately 350 barrels of water daily. The corrosion rate before and after inhibitor injection into the water supply wells is tabulated in Table 3.

Judging from the last test periods, coupons indicate a reduction in corrosion rate of 97 percent at the water supply well, 98 percent at injection well A, and 96 percent at injection well B.

REFERENCE

[1] Mils penetration per year, where a mil represents .001 inch.

ACKNOWLEDGMENT

Published through courtesy of Corrosion Control Short Course, University of Oklahoma, and Tretolite Company, St. Louis, Mo.

**TABLE 2**
**History of Corrosion in Water-Flood System**
**Corrosion Inhibitor Introduced Down Casing Annulus of Water Supply Well**

| Test Period | Volume Ratio Water/Inhibitor | CORROSION RATES, MILLS PER YEAR | | | |
|---|---|---|---|---|---|
| | | Supply Well-Head | Reserve Tank | Input Well No. 1 | Input Well No. 2 |
| May 27 to June 12, 1950 | No Inhibitor Used | 18.2 | 13.3 | 9.6 | 10.4 |
| June 12 to July 15 | No Inhibitor Used | 26.7 | 11.6 | 9.0 | 10.7 |
| Sept. 12 to Sept. 26 | 88,200 | 1.1 | 1.8 | 1.0 | 0.79 |
| Oct. 11 to Oct. 24 | 101,500 | 0.55 | Not Determined | 0.57 | 0.63 |
| Oct. 24 to Nov. 14 | 101,500 | 0.58 | Not Determined | 0.37 | 0.37 |

**TABLE 3**

| Test Period | Inhibitor PPM | Supply Well Corr. Rate (MPY) | Injection Well A Corr. Rate (MPY) | Injection Well B Corr. Rate (MPY) |
|---|---|---|---|---|
| 5/27-6/12 | None | 18.20 | 10.37 | 9.57 |
| 6/12-7/15 | None | 26.70 | 10.70 | 9.00 |
| 9/12-9/26 | 11.4 | 1.11 | 0.79 | 1.08 |
| 10/11-10/24 | 9.8 | 0.55 | 0.63 | 0.57 |
| 10/25-11/14 | 9.8 | 0.58 | 0.37 | 0.37 |

—The End

TexPet's floating camp on the Maranon river is serviced by weekly flights from Taleara and Chiclaye.

# TexPet's Peru Exploration Is Unique and Costly Operation

**Rough terrain and floods in the Oriente region have been overcome as watershooting and slim-hole drilling continue.**

**By H. T. BRUNDAGE**
World Oil Staff

Texas Petroleum Company had reached a depth of 9787 feet in early November on Maranon 8.1, the first test well on the company's 2.5-million acre concession in eastern Peru. TexPet, a wholly-owned subsidiary of The Texas Company, is using some unusual techniques to overcome unusually tough local conditions. Watershooting is among the unusual techniques used. They also have used a floating camp for the drilling crew and a tailor-made slim hole rig.

Nature imposes great hardships on exploration in the Oriente (eastern Peru). First, the region is exceedingly remote. The Andes Mountains, rising to 12,000 feet between TexPet's con-

Tubular goods and chemicals are hauled to the drilling site by barge from Iquitos.

Dynamite charge is set off by TexPet seismic crew in the Maranon river. Floats support cable with 32 geophones attached to it.

cession and the Pacific coast, block off access to the Oriente country except by airplane. Heavy equipment, including a specially-designed and assembled rig which traveled 5500 water miles from the U. S. all the way up to the headwaters of the Amazon river, all must take the long Amazon river haul. Detailed planning is essential to avoid costly shutdowns.

The flash flood is another hazard in eastern Peru, particularly in the Maranon valley. The Maranon river, the main headwater of the Amazon, flows due north for the first 460 miles of its course through a narrow valley. Where it breaks out of the Andes range, it swings abruptly eastward, receives a boost in volume from the southward-flowing Rio Santiago, and flows through a constricted gorge called the Pongo de Manseriche, 20 miles northwest of the west edge of TexPet's block.

At its narrowest point, the Maranon is only 400 feet wide but broadens to 2000 feet only a mile farther downstream in the Pongo. As a result, the river level is extremely erratic, particularly in the flat country below the Pongo. It commonly rises as much as 7 feet in three hours, and varies from 16 to 20 feet where the river flows through TexPet's permit. To make matters worse, often there is no warning below the Pongo, as it may be pouring rain in the upper Maranon valley while the weather may be bright and clear in the nearby flat country to the east. Field parties in remote sections of the Oriente are known to have been abruptly awakened during the night by a sudden flood of water, with no recourse but to cling to tree branches till the water level falls.

To combat this situation, quarters for the drilling and seismic crews are big modern houseboats, originally designed for petroleum exploration and operations on inland waterways in southern Louisiana.

Though numerous geological field parties are working in the Oriente country, their work becomes more difficult and less conclusive east of the fairly ample outcrops in river valleys in the foothills of the Andes. Due to heavy vegetation, lack of roads and trails, poor communications, and the thick mantle of essentially nonprospective, non-marine Tertiary beds overlying the more promising Cretaceous sandstones, greater reliance is being placed on seismic exploration. The Cretaceous sandstones are the main target of TexPet and other concessionaires in the Oriente.

Normally, the same obstacles would preclude effective seismic work, too. The difference is that the many rivers and streams, all supplied by the Amazon system, including the Pastaza, the Morena, and other smaller streams entering the Maranon, make it possible to do watershooting and thereby produce a close enough spacing to afford fairly good reconnaissance reflection and refraction seismic work.

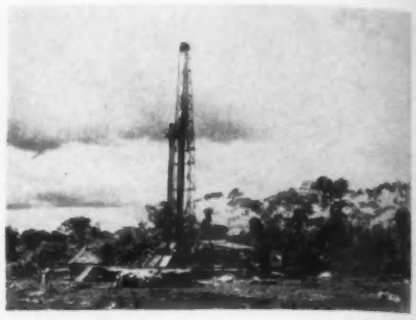


Photo taken as the company's first test well in Peru, Maranon 8.1, reached 7400 feet. With this light rig, drill tubing rather than drill pipe is used.

TexPet's Cocuina, a 165-horsepower utility river boat, is used to tow an 1826 foot marine cable, which is supported by floats. As many as 32 geophones are attached to this cable, and submerged. The geophones record shock impulses created by dynamite charges detonated every 700 feet in the water. Heavy charges, of between 25 and 100 pounds, have been used. Though they have been set off within two feet of the surface in shallow water, best results generally are being obtained with geophones on, or close, to the bottom in deeper water.

Seismic work here is essentially similar to techniques used by companies exploring in the Gulf of Mexico, adapted to an area of (usually) dry land where the only convenient access is by water. It requires considerable special equipment, including a tugboat, a large barge, two houseboats, a diesel launch, various small outboard-driven boats, and a PBY amphibian supply and personnel plane. The larger floating equipment was transferred via the Amazon from the Orinoco river delta in Venezuela, where it was used in a previous company project.

A Texas geophysical firm furnished seismic instruments and specialized personnel, having done similar work for Petrobras, the Brazilian oil monopoly, in the lower Amazon basin.

Record quality has been fair to good, though there are some areas of negative results due to excessively soft sand and mud, and possibly to local pile-ups of plant debris. Submerged tree trunks tend to ensnare detectors and to tear up recording cables. Operations were delayed once for three weeks when the first cable was lost. A spare cable is kept on hand during

seismic operations since that mishap occurred.

Seismic velocities have been checked by the refraction method, but this is naturally inconclusive since it represents essentially a horizontal measurement. A better check on velocities will be had when a survey is run in Maranon 8.1, now being drilled.

Due primarily to the favorable 1952 Peruvian oil law and also to disappointing exploration results west of the Andes, much interest has been focused on the Oriente during the past three years. As of April 1, 1955, 22 million acres were under permit to the many participating companies (see WORLD OIL, August 15, 1955, pp. 208-214, concessions map on p. 210). Largest acreage-holders were Peruvian Gulf Oil Company, TexPet, Socony Vacuum Development Company of Peru, and Richmond Oil Company, each holding more than 2.7 million acres. TexPet's recent exploration has contributed to greater recent activity. Aerial surveys have been conducted by both TexPet and Socony. In this regard, Ganzo Azul, or Agua Caliente field, is a Cretaceous surface structure that was originally noted from the air.

Geology of the Oriente is only sparsely known. In the Andes foothills, there are some highly complex known structures. One is visible in the Pongo de Manseriche, with dips of from 70 degrees to vertical. There, Tertiary-Cretaceous red beds are thrust over younger Tertiary on the east limb of the anticline, and lower Cretaceous sandstones are exposed in the center of the structure.

Farther eastward, the structural deformation may be less severe, but thickness of the Tertiary mantle in different localities poses a big question mark. Big facies changes, over moderate horizontal distances, are indicated in the Cretaceous beds.

In the Pongo, a sandstone is at least 1000 feet thick. In most places where the Oriente Cretaceous is known, thick basal Agua Caliente sandstone, productive at Ganzo Azul, 310 miles south of TexPet's block, is overlain by the Chonta shales and limestones, which is in turn overlain by the Vivian or Sugar sandstone that occurs on the surface at Ganzo Azul. The Cachiyacu shales and siltstones overlay the Vivian. Tertiary redbeds, greatly varying in thickness, have a very wide areal extent, continuing far to the north in Ecuador and also far to the south in the Peruvian Oriente.

**With Maranon 8.1 in the background, this group returns to the floating camp after a flight from Iquitos, 250 miles east. In the skiff are Richard E. Wright, standing, manager, TexPet's Producing division in Peru, and left to right: Pharmacist Aguilar, who is doubling as boat attendant; Gabriel Tudela, in charge of Westinghouse's operations in Peru; I. B. A. Rokes, TexPet agent in Iquitos; E. G. Tilston, manager, Booth Steamship Company, Iquitos, and an unidentified boat attendant.**

Thus far, no commercial oil has been found under somewhat similar conditions in Ecuador and eastern Columbia. However, Ganzo Azul has proven to be a good field, lacking only an adequate market, up to the present time.

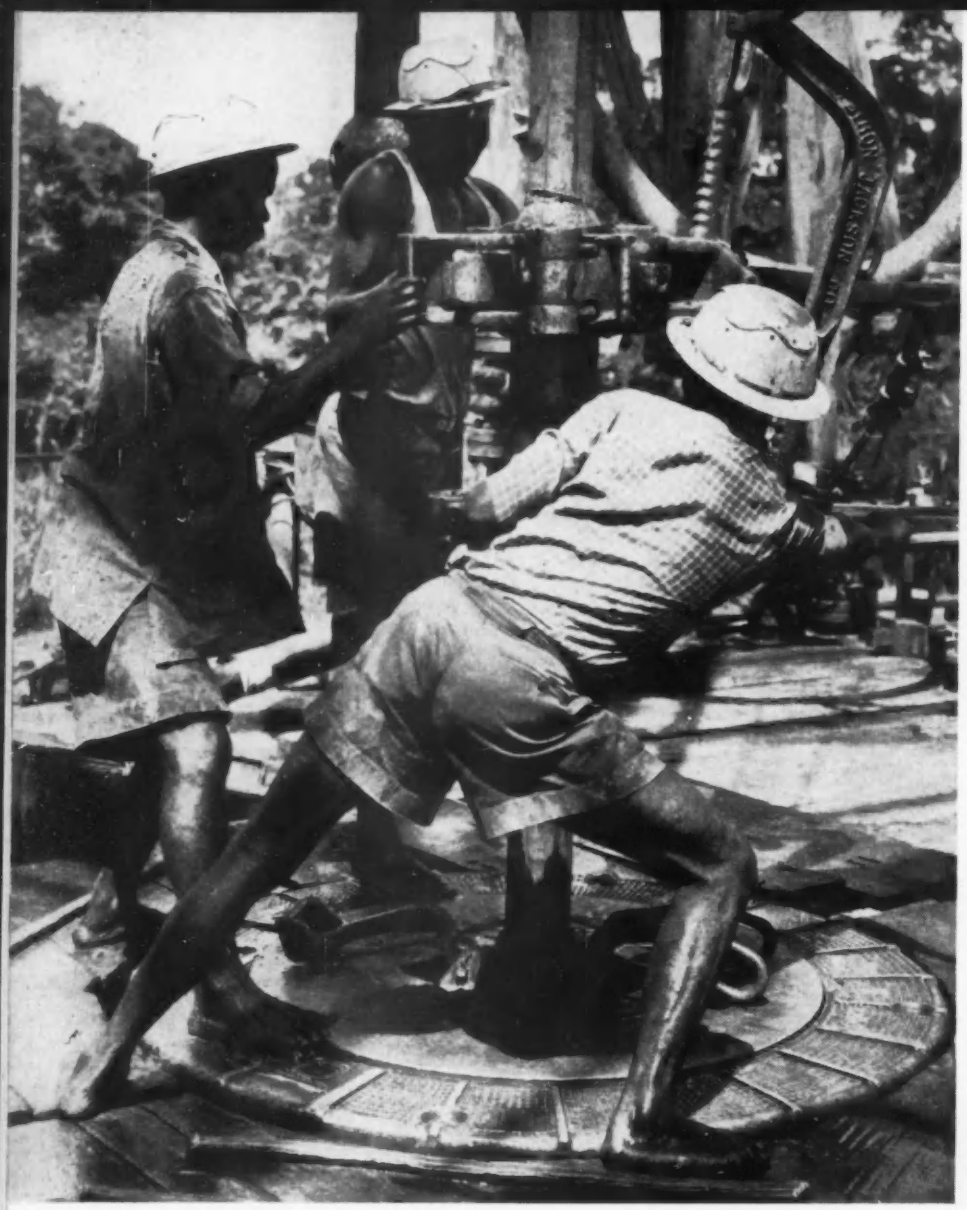
TexPet's unique Maranon 8.1 rig, the transporting and assembling of which was described in WORLD OIL, October, 1955, pp. 265-267, is rated to 11,000 feet, using 3½-inch OD grade N-80 drill tubing, weighing 11 pounds per foot. Lime base mud, weighing about 11.8 pounds per gallon, was being used at the greatest depth reported so far.

The drilling crew personnel is provided by Santa Fe Drilling Company. Peruvians are used in all phases to as great an extent as possible. Normally, the ratio is 80 nationals to 20 non-Peruvians, in accordance with the law. The drilling crew used in this venture is a seasoned group, some of the nationals being third-generation oil workers from Peru's western desert.

One of the world's oldest active oil wells was still pumping oil in 1954 in its 65th year in the La Brea-Parinas field near Talara on the west coast, native Peruvian oilfield experience goes back at least that far. Crews are rotated home every three weeks by planes based at Talara and Chicolayo. The Peruvian drilling crew was "green" in but one respect—some of the members had never before seen rain. Rain seldom falls in the desert section along the Pacific coast.

Economic and logistic problems in this venture are huge. Exploration in the Oriente is expensive. Only equipment which can be transported by plane can be supplied in anything approaching a hurry, and Porculla Pass, the lowest elevation in the Andes between the Oriente and the coast, is 7000 feet high.

Oil that might be taken out of the Oriente by boat would have a difficult time competing with Venezuelan oil transported to any market by the same means. Probably the most painful thing that could happen to TexPet and other companies operating in the Oriente would be to find mediocre production. The key to making money from Oriente oil or, for that matter, even breaking even, will lie in finding enough to justify construction of a 400-mile pipe line through Porculla Pass to the port of Bayovar on the Pacific coast. —**The End**



This drilling crew is in action at Nzam, 70 miles north of Owerri.
Shell Photograph

In 1937 initial Nigerian reconnaissance work was begun: from Lagos west; from Calabar North.

# NIGERIA

*". . . If oil in commercial quantities materializes, it will be an event of profound economic significance to the people of the country."*

**By V. S. SWAMINATHAN**

AS FAR BACK as 1937 a handful of geologists landed in Nigeria, in tropical West Africa, and began one of the most extended and difficult oil exploration programs of all time. Today, this quest is continuing with unabated vigor.

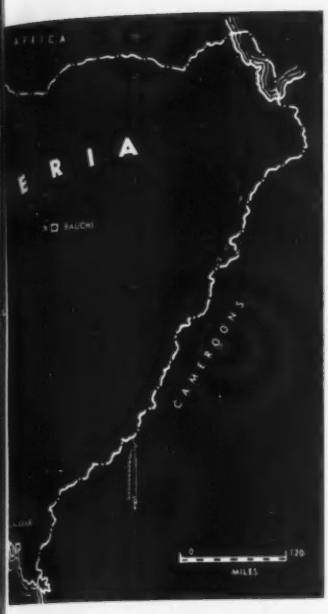
The handful of pioneer oil men living in tents has blossomed into an organization housed in a self-contained camp. More than 2300 people are at work, of whom 2000 are Nigerians.

The remainder embrace specialists from several European countries. Already, more than $30.8 million has been spent without finding commercial quantities of oil.

The present operating company is The Shell-D'Arcy Petroleum Company of Nigeria, Ltd., Incorporated in September, 1951, which replaced Shell-D'Arcy exploration parties. "Shell" Overseas Exploration Company Ltd., a member of the Royal Dutch-Shell Group, and D'Arcy Exploration Company (The British Petroleum Company Ltd.'s exploration wing), each holds 50 percent of the shares.

Initial operations began in 1937 with a rapid geological reconnaissance made over the entire sedimentary areas from Lagos, in the west, to Yola, in the east, and from Calabar to Sokoto. Subsequent prospecting was confined to the southern sedimentary region for which the government issued an exploration license.

The company continued the geological survey from 1938 to 1941 and carried out gravity surveys in the Onitsha/Okigwi/Owerri areas, and in the Deltaic tract. One seismic party was active in the Okigwi/Owerri/Imo river areas. Besides, several shallow coreholes were drilled in the Awgu/Ishiago/Ngusu areas.




Almost two decades and millions of dollars later, the effort continues, aided only by oil showings.

**—the never-ending search for oil . . . $30 Million spent . . . Shell-D'Arcy remains on 24-hour schedule.**

Work was interrupted, however, at the beginning of 1941 because of World War II. It was renewed in September, 1946, with two geological parties. One gravity party and one seismic party went into the field two years later.

One major problem at that time was that a substantial part of the concession area was covered by the Niger delta, of which there were virtually no accurate topographical maps. So the company mapped about 15,000 square miles of the delta by aerial survey operations which were completed in 1953. By the end of 1951, the exploration effort had been expanded to two geological parties, two gravity and three seismic parties. From this effort sufficient geological information was obtained to start the drilling phase of the operation in the search for oil.

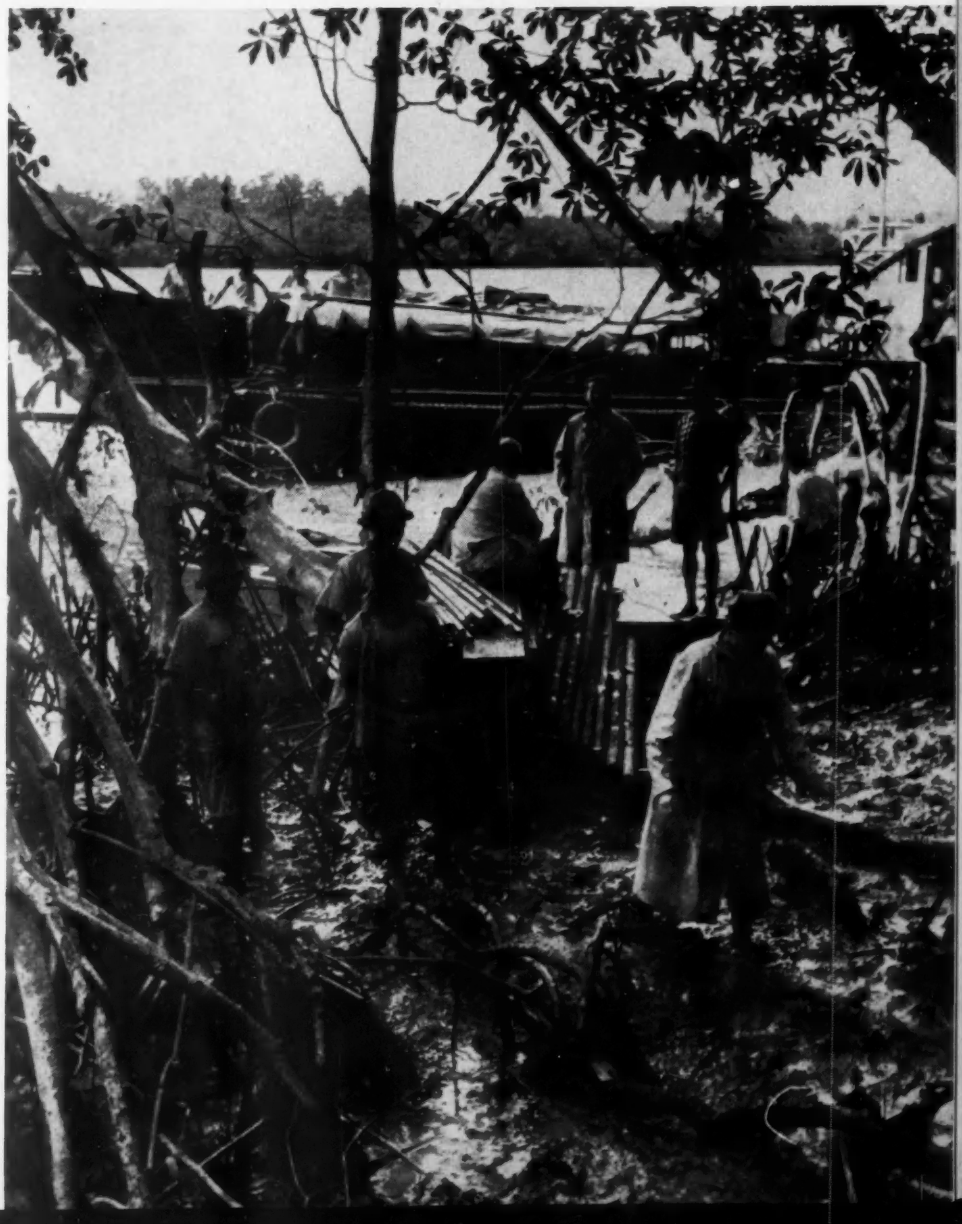
The first deep test well (spudded-in during September of the preceding year at Ihuo, eight miles north-northeast of Owerri, with a U. S.-manufactured rig) reached a depth exceeding 11,000 feet before it was abandoned. The rig was transferred to Akata in the Calabar province. During 1952, two more rigs started operations—a deep drilling rig and a core drilling rig. The former spuded-in a deep test well at Amansiodo, in Onitsha province; the latter drilled two holes at Gebekebo and Araromi in Ondo province.

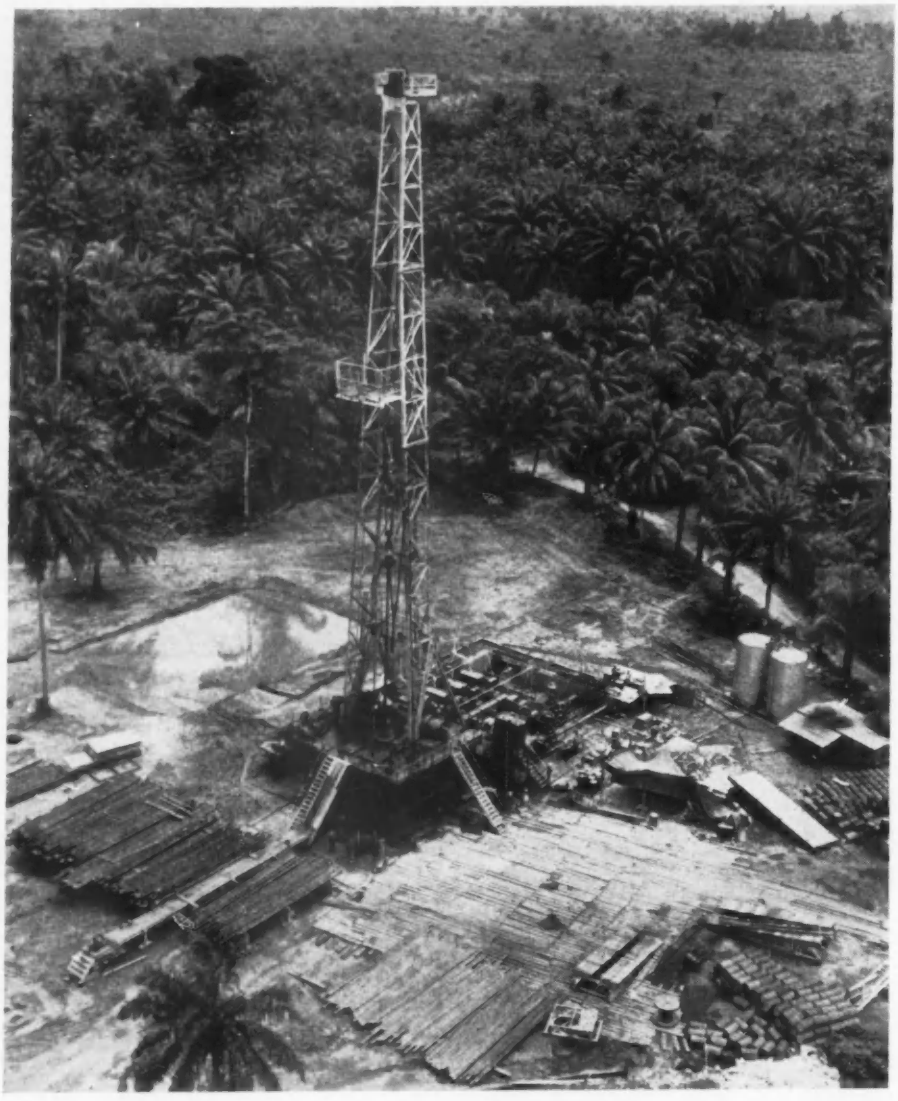
In 1953, the Akata test encountered showings of oil, mixed with a considerable volume of gas. Amansiodo deep test was completed at the end of 1953, finding only gas. The core drilling rig drilled three holes at Auchi/Egoli, Owan and Ubiaja in Benin province. In the latter part of the year, a fourth drilling outfit—a mobile truck-mounted rig—began operations by drilling four coreholes at Afikpo in Ogoja province.

In 1954, a test was begun at Nzam on the Niger banks north of Onitsha, and drilling continued throughout 1954. Test holes also were drilled near Okigwi, Ituk Mbang and one near Benin City—the first test well to be drilled in the Western Region.

Showings of oil were found at Ituk Mbang and minor indications with large volumes of water near Benin City. Three core holes were drilled at Idah in Kabba province, and at Okpaya and Bopo in Benue province.

**To keep The Shell-D'Arcy Petroleum Company surface exploration going, this landing craft is unloading supplies for Party No. 1.**





Nigerian wildcat, drilled with a U. S. drilling rig, located at Akata, in Calabar province.

The Owerri Camp contains the Shell-D'Arcy Club, right, bachelor quarters and houses.

The mobile truck-mounted rig drilled four core-holes on the outskirts of Calabar town.

In mid-1954 Shell-D'Arcy drilled three wells at Akata during the year. The first found only gas, the second was abandoned due to mechanical difficulties, and the third, drilled as a replacement hole, was dry.

In May, 1955, the Nzam well was abandoned at a depth of 12,046 feet, a record depth for Nigeria, following disappointing test results. The rig from that well now is drilling at Oloibiri in Brass Division. In March, a rig was moved to Benin, and a new exploratory well was spudded-in at Akukwa in Onitsha province. This well subsequently blew out, producing large quantities of gas, and, after being brought under control, was abandoned. Further drilling in this area is expected.

A well was being drilled at Umuna in Owerri province late in 1955. The core drilling rig was racked after two core-holes were completed at Adoka and Ikem, both in Benue province, and a contract rig was drilling a further outstep well in the Akata area, having completed a well at Ekim in Calabar province, where promising shows of oil were encountered.

To conduct these operations, the company maintains 90 staff cars, pickups and land-rovers in addition to 120 heavy lorries and trailers for rig-moving and seismic supply, school buses and bicycles for the Nigerian messengers. Water transport also is used extensively, and the inland waterway network has to come into play in Nigeria. Shell-D'Arcy operate two LCM's and one LCT for heavy transportation, six houseboats for accommodating personnel, ten launches and speed boats and two tugs. Three helicopters, too, are operated by the company.

In Owerri Camp, the Accounts department has more than 30 persons handling pay, cost and budget problems. About 140 employes in Materials department care for the $2.8 million worth of equipment usually kept in stock, and to ensure that the supply lines converging from the U. S., Europe and local firms are kept going.

Shell-D'Arcy employs about 200 expatriates on its staff. They and many of their families live in a country where there are few outside entertainments to their liking, and where the climate and the diseases exact respect and incessant care. Owerri's residential area contains family quarters, bachelors' bungalows and a rest house for temporary residents and visitors. These houses are set in regular lines, and each is surrounded by an extensive garden. A large modern club provides a focal point for dances, social gatherings and parlor games.

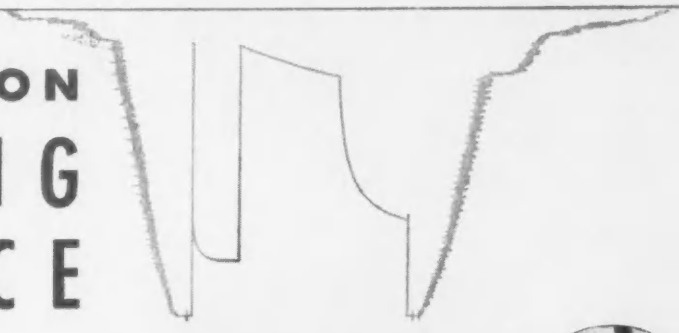
For the sportsmen, there are tennis, squash, badminton, cricket, football, table tennis, billiards and snooker. For the reader, a comprehensive library is maintained and for the film fan, a twice weekly film feature. Children have their own movies and a playground.

Most of the regional staff live outside this camp, and they have a well-equipped club and athletic facilities.

Some day, perhaps, oil in commercial quantities may be found in tropical Nigeria. If that materializes it will be an event of profound economic significance to the people of the country. And for the men who work with Shell-D'Arcy, both nationals and expatriates, it will be a fitting reward for the never-ending, and expensive, labors they have put into the search. —The End

# *Dual CIP Improves Reservoir Evaluation*

## HALLIBURTON TESTING SERVICE



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- **C** A Final Closed-In-Pressure buildup curve is obtained for comparison with the Initial curve.
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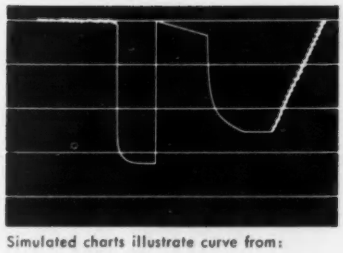
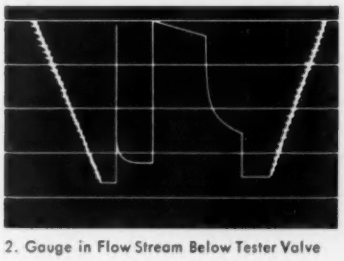
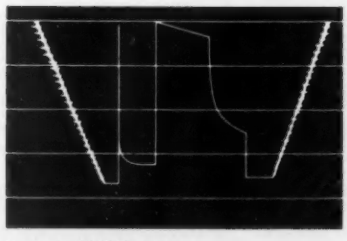


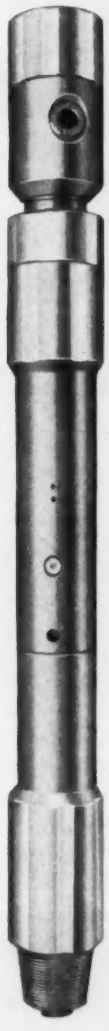
Simulated charts illustrate curve from:
1. Gauge in Air Chamber



2. Gauge in Flow Stream Below Tester Valve



3. Blanked-Off Gauge



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This is Parentis Well 15 on the south shore of Lake Biscarrosse. Photo by Ray-Delvert

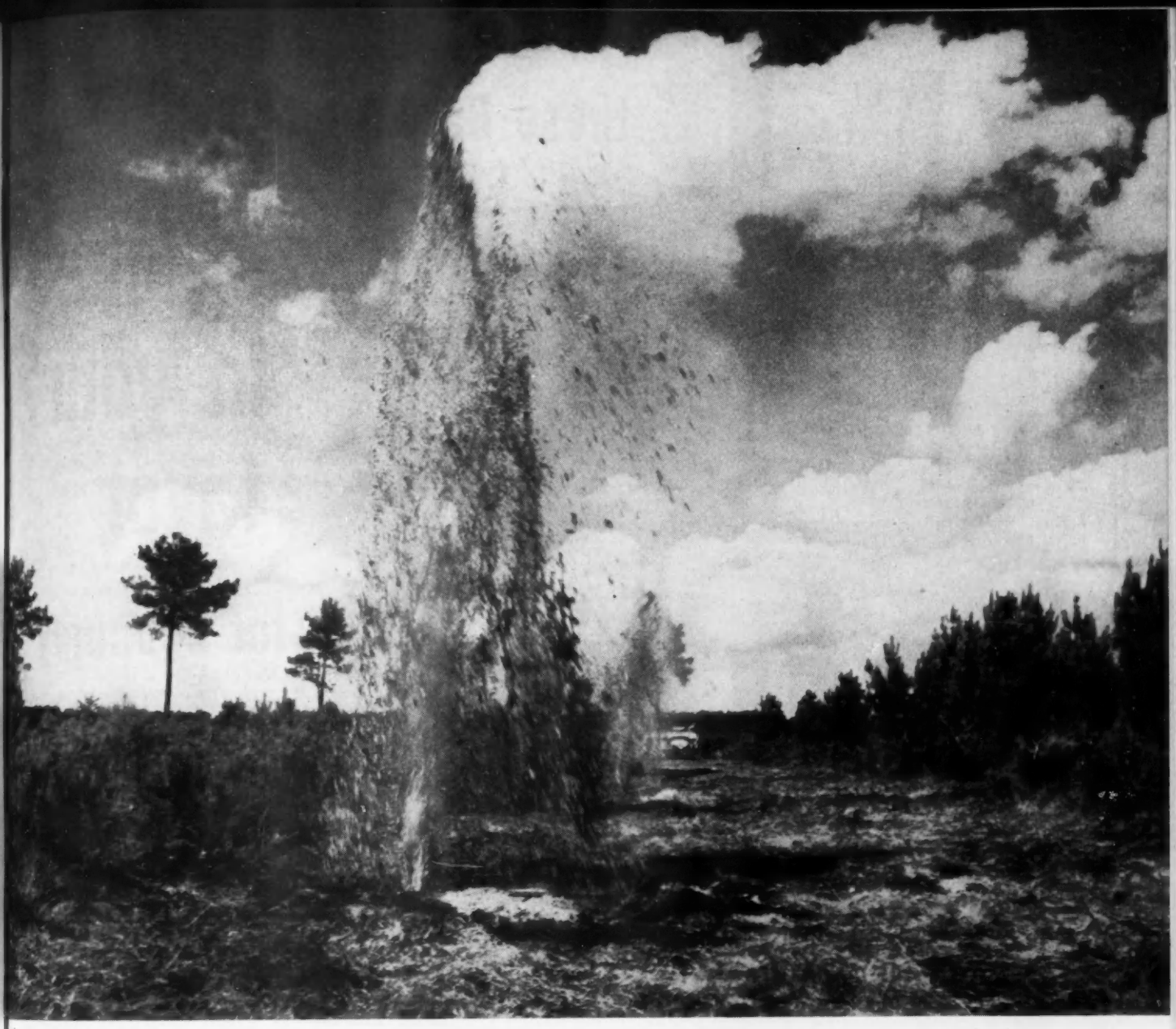
# Parentis Is Fast Developing Into Major European Field

**Production now exceeds 14,000 barrels a day from 11 producing oil wells. Many locations remain to be drilled in Lake Biscarrosse.**

PARENTIS FIELD, now in its second year of production, already is producing at the rate of 5 million barrels a year. Soon, it is expected to surpass Schoonebeek, Western Europe's largest field which straddles the border between Germany and The Netherlands. Total cumulative production from Parentis as of September 1, 1955, was 3,605,000 barrels.

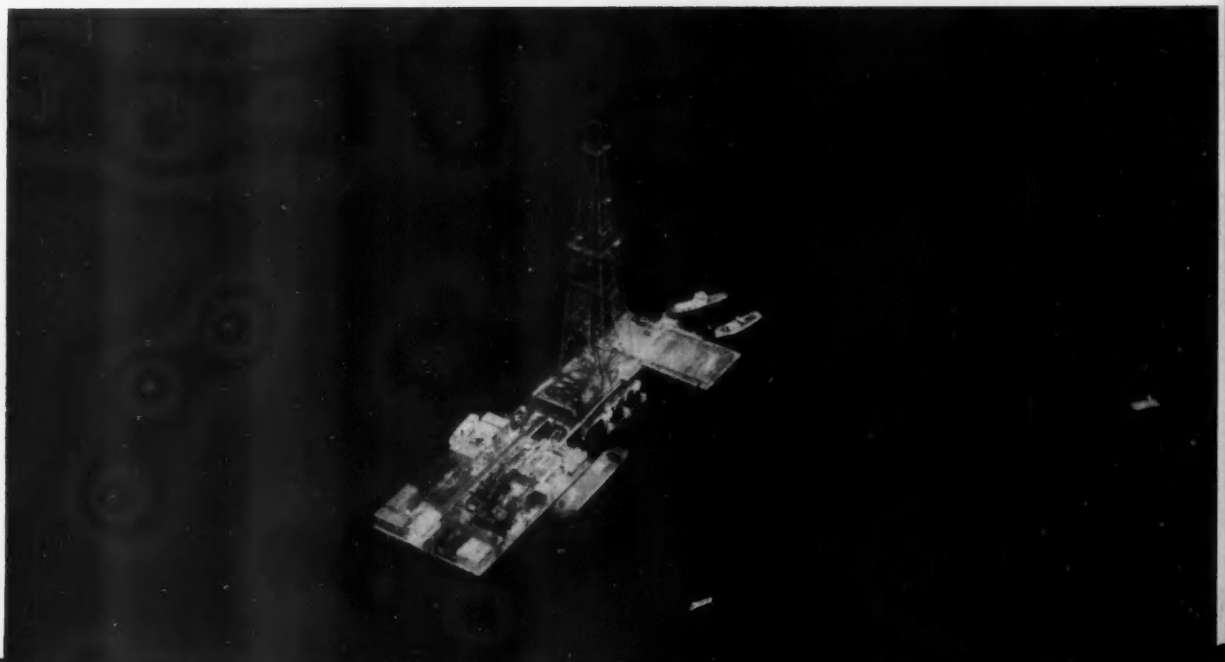
Discovery and development of Parentis field jolted French oil exploration into the center of interest. Today, a frenzied scramble for exploration permits is taking place, not only in the Aquitaine Basin north of the Pyrenees, in which Parentis lies, but also in every other part of France where a reasonable section of sedimentary rocks occurs. More than 50 exploration concessions have been ap-

French workmen of Esso Standard SAF lay a pipe line from Parentis 1 to storage tanks.



Esso's exploration continues in southeastern France. Five seismic crews were operating in the field on the French concession in October, 1955.
Esso Photo

Esso's first offshore well in the Parentis field, Well 11 a producer, was drilled in Lake Biscarrosse from this platform in 17 feet of water.
Photo by Ray-Delvert



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plied for in all of France, at least 20 of them in the Paris Basin alone. More than 30 French companies, the majority of them of post-Parentis vintage, are organized to undertake exploration.

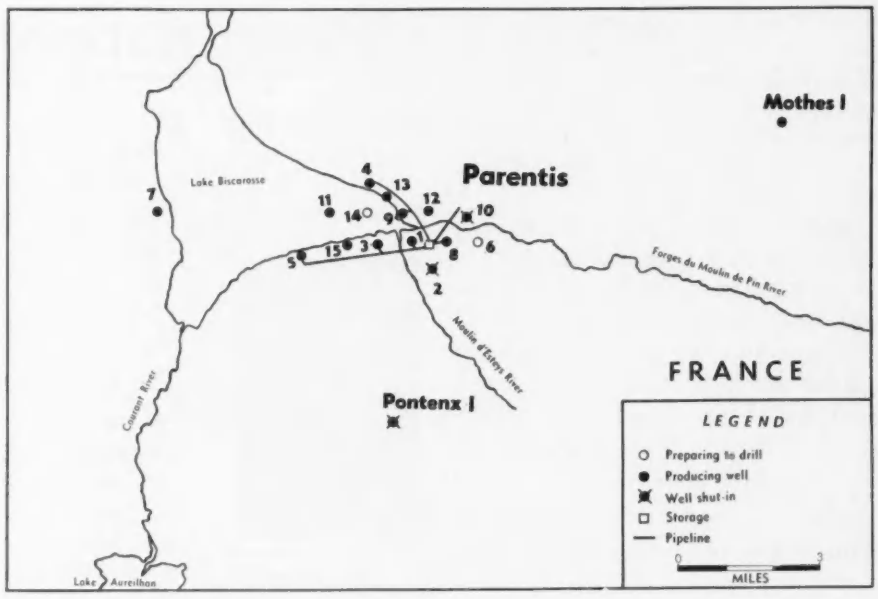
The original 4.3-million acre concession from the French government was granted to Esso Standard SAF, owned 63.2 percent by Standard Oil Company (New Jersey), 18.349 percent by Gulf Oil Corporation, and 18.451 percent by 5000 different French investors.

The Parentis discovery was primarily a triumph of geophysical methods, in particular reflection seismograph. The gravity survey on the concession, initiated May 1, 1951, was completed in the spring of 1952. The first seismic crew began work immediately thereafter. Seismic crew-months totaled eight in 1952, 14 in 1953, 35 in 1954, and five seismic crews were in the field in October, 1955.

The Parentis discovery well was the second wildcat test on the concession. Completed in March, 1954, Esso Parentis 1, located 40 miles southwest of Bordeaux in flat country near the Bay of Biscay coast, flowed 1100 barrels of 33.5-gravity oil daily through a quarter-inch choke from lower Cretaceous dolomite between 7290 and 7867 feet. Development has proceeded rapidly, due largely to the unusually fast action by the French National Assembly which passed a special law allowing production. By October, 1955, 11 producing wells had been completed, and daily production was more than 14,000 barrels.

The productive area thus far proven is more than six miles in length along the east-west structural axis, and about two miles in width. Most of the wells drilled have defined the extremities of the field, and most of the remaining inside locations lie in Lake Biscarosse.

Parentis 11, recently completed, was drilled in the eastern part of the lake from a platform built in 17 feet of water, and Parentis 16 was drilled directionally northward under the lake from a south shore surface location west of Parentis 5, an oil well. Deviation of well 16 reached a maximum of 17½ degrees at 4344 feet, and the bottom hole location will be west of Well 16 and 3300 feet north of the surface location. When Parentis is drilled up, it probably will present a surface appearance similar to Maracaibo or Copano Bay.




Normally, Parentis well require three months to drill, not because of any major drilling problems, but due to the thorough manner in which the company cores them. The oil column at its maximum measures more than 1500 feet. As much as 1000 feet of coring may be done in one well.

Geologists and engineers (most of Esso Standard S.A.F,'s employes are French nationals) are particularly interested in the description and analysis of the cores, especially in the types of porosity and permeability. Dolomitic, fracture and vugular types of porosity occur.

The only significant drilling troubles occur in the pay section, where the drill has been known suddenly to drop as much as six feet upon penetration of a big cavity, and as much as 75 barrels of mud is commonly lost in the pay zone. However, since there is little danger of sticking the bit, no unusual remedies are employed. No major fishing jobs have developed.

Where good dolomitization of the Neocomian (lower Cretaceous and upper Jurassic age) limestone occurs, good production (between 1000 and 2000 barrels daily per well) results; production from non-dolomitized limestone is much less prolific. One of the flank-area wells encountered dolomite only at the oil-water contact and below.

It was plugged back, acidized in the non-productive appearing limestone above the water level, and completed as a pumper for about 300 barrels of oil daily. The oil-water contact is not erratic, and bottom-hole pressures have equalized well, indicating that excellent permeability exists throughout the field as thus far developed. Bottom-hole pressures are about normal for the depth—about 3400 pounds at 7500 feet.

Generally, 7-inch casing (of European manufacture) is run to the top of the dolomite, and the wells are completed with all of the pay section open.

No definite pattern to the erratic dolomitization appears to exist. It is likely, however, that the large anticlinal uplift here may have effected fracture permeability, which, in turn, allowed secondary dolomitization.

A new field, located seven miles east-northeast of Parentis, at Mothes, was discovered by Esso Standard SAF during the summer of 1955. The pay section is a limestone equivalent to the Parentis pay, but unquestionably separate from Parentis.

The northeast limit of Parentis field has been defined by Well 10, a dry hole, and by well-established faulting. Mothes 1 was completed for 350 barrels daily in a section that did not show for production in open hole, and the well might have been aban-

doned except for the experience the company had gained with Parentis flank wells. Esso currently is drilling to further evaluate the Mothes discovery. Total cumulative production to Sept. 1, 1955, from Mothes was 50,000 barrels.

Esso's exploration is continuing throughout the permit area. Surface geology is inadequate because a definite unconformity exists between the Tertiary and the more prospective Cretaceous beds below. Many water wells have been drilled in the area—some as deep as 1000 feet—and the logs have been helpful.

Reflection seismograph is the main exploration technique. In seismic work, as many as 500 geophones are being used per shot. Usually, shot holes are about 30 feet deep, and about six pounds of dynamite are detonated in each shot. The section is dominantly limestone, and seismic velocities are very high. Records generally have been rather poor.

An especially interesting phase of the current seismic work is a three-month program to evaluate the part of the concession lying offshore from the coast. Essentially the same techniques used by U. S. companies in the Gulf of Mexico are being utilized. Esso's concession extends one and one-half miles offshore at the southern end near Parentis, four miles out at the north end near La Rochele, and, opposite the mouth of the Gironde River, it lies a maximum of 12 miles seaward from the coast.

Recent wildcats testing seismic structures include one at St. Paul, six miles south of Parentis, and another at Ychoux, 3½ miles south of Mothes. Both wells were below 4350 feet by October 1, 1955.

At least six other seismic prospects on the concession have been drilled with negative results.

The nearest production to Parentis and Mothes is at Lacq, 60 miles to the southeast near the Pyrenees mountains, where gas is produced from the equivalent of the Parentis pay zone .

Production from Parentis Field is being shipped by railroad tank car. Most of it is processed at a refinery in the Le Havre area. —**The End**

# What's Happening

## AMONG WORLD OIL MEN

CECIL MORGAN, government relations counselor for Standard Oil Company (New Jersey) since October, 1952, and a former vice president and director of Esso Standard Oil Company, has been appointed executive assistant to Jersey Standard's chairman of the board, Eugene Holman.

Cecil Morgan

With the Jersey organization since 1936 when he joined Esso Standard's legal staff at Shreveport, La., Morgan succeeds GEORGE KOEGLER, who recently became Jersey's deputy general counsel.

Before joining Esso Standard's legal staff, Morgan served as a U. S. Commissioner in the Western district of Louisiana; as representative and senator in the Louisiana legislature, and as a judge in that state's first judicial district.

He became a vice president of Esso Standard at Baton Rouge in 1949 and transferred to New York in January, 1952, after his election to the Esso Standard board of directors.

T. O. COLLINS has been transferred by Texas Petroleum Company from Colombia to Venezuela as drilling foreman.

D. G. Sawyer, petroleum engineer, recently was transferred by TexPet from Colombia to Venezuela.

J. E. Brown, petroleum engineer, has joined the Venezuelan organization of TexPet.

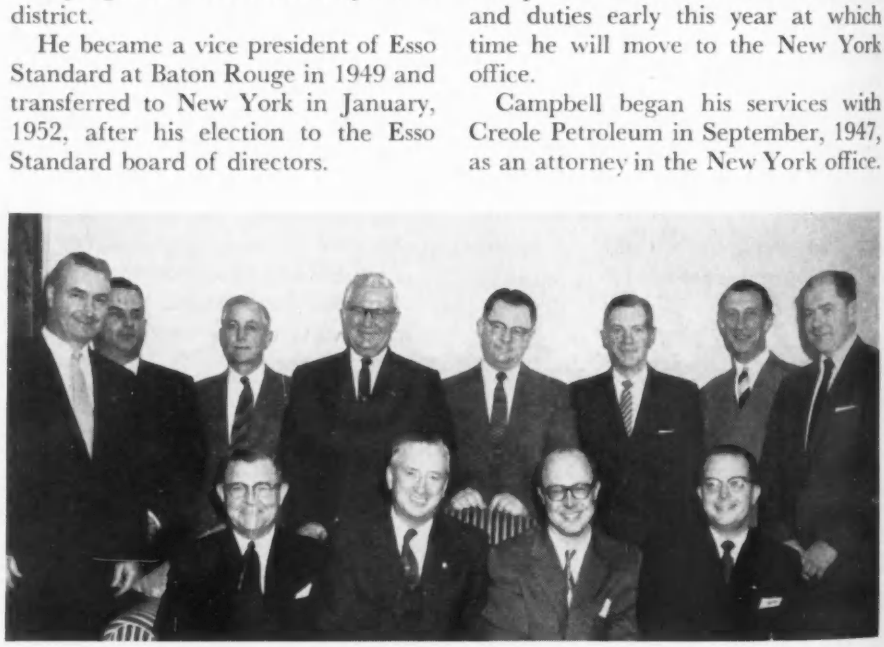
•

MAURICE SAMUEL, of France, engineer with Regie Autonome des Petroles, Southwest division, was scheduled to leave the U. S. in January after spending several months visiting oil fields and other industry installations in the U. S. Samuel's headquarters are in Boussens (Hte Gne), France.

•

NICHOLAS J. CAMPBELL, JR. has been elected a vice president of Creole Petroleum Corporation. Manager of the Law department with headquarters in Caracas, Venezuela, Campbell will assume his new title and duties early this year at which time he will move to the New York office.

Campbell began his services with Creole Petroleum in September, 1947, as an attorney in the New York office.



### *Oil Group Names Board of Governors*

**G. L. Knox, Calgary, Alberta, president, The California Standard Company (seated, second from left), was elected chairman of the board of governors of the Canadian Petroleum Association at the third annual meeting of the group at Calgary. Other elected members of the board are (left to right, sitting): C. U. Daniels, Royalite Oil Company; Knox; P. L. Kartzke, Shell Oil Company, retiring chairman; George Dunlap, Sun Oil Company, chairman, CPA's Alberta division. Standing are: D. M. Tyerman, MacPherson, Leslie and Tyerman; R. A. Cruickshank, Canadian Devonian Petroleums, and chairman, CPA's Saskatchewan division; V. H. Hunter, Imperial Oil Limited; Bart W. Gillespie, Oilwell Operators Ltd.; C. E. Leach, Tidewater Associated Oil Company; Vern Taylor, Imperial Oil Limited; T. W. G. Thomson, Texaco Exploration Ltd.; and E. D. Loughney, Canadian Gulf Oil Company. Not shown are R. A. Bishop, Sohio Petroleum Company; and R. C. Brown, Hudson's Bay Oil & Gas Company, Calgary.**

# a WORLD of OIL

By **DON KLIEWER,** World Oil Staff

George R. Ferguson

William E. Murray

GEORGE R. FERGUSON has been appointed general manager of California Texas Oil Company, Ltd.'s newly-formed North European division, which consists of the United Kingdom and Ireland, Algeria, the Azores, Iceland, Tunisia, Scandinavia, the Benelux countries, Finland, France, Germany, and Switzerland. He was formerly general manager of the Caltex Far East division.

Ferguson, who has been with Caltex since it was formed in 1936, will be replaced in his former position by WILLIAM E. MURRAY, who has many years of experience with Caltex in the Orient.

William Schwarz, formerly Caltex shareholders representative in Italy, has been appointed general manager of the new South European division, which consists of Austria, Cyprus, Gibralter, Greece, Italy, Portugal, Spain, Tangiers, Turkey, and Yugoslavia.

S. H. KUHN, who has been with Caltex and predecessor companies for 35 years, has been named general manager of the Australasian division.

In addition, THOMAS W. DONLON has been appointed general manager of the producing division, California Texas Oil Company, Limited.

•

HENRY E. McAULIFFE has been named vice president and general manager of Mobil Oil Company de Colombia. He will succeed A. D. GRAVES, who returned to the company's New York office to serve as assistant to the producing committee member responsible for Eastern Hemisphere operations.

McAuliffe joined Socony Mobil as a petroleum engineer in 1945. Since 1950 he has been in charge of special studies in the Producing department. He is a past chairman of the New York Petroleum Section of the American Institute of Mining and Metallurgical Engineers.

**AFRICA:** Regie Autonome des Petroles has struck oil in a 3600-foot test drilled near Port Gentil in French Equatorial Africa. The well produced at a rate of about 2000 barrels daily but was shut in, pending arrival of production equipment.

**CANADA:** Imperial Oil Company Ltd. plans to drill one or two wildcats in Quebec province this year. During 1955, company seismic crews were active in the lowland areas along the St. Lawrence river.

**CUBA:** Crude production from the four principal producing areas—Jatibonico, Jarahueca, Motembo, Bacuranao—amounted to 1459 barrels a day in December, according to Cuba Petroleum News Digest.

**EGYPT:** International Egyptian Oil Company's new discovery, which tested a second producing zone at 6300 feet, was brought in with a flow at the rate of 100 barrels an hour—extending the No. 2 zone about three-fourths of a mile east of the discovery well, Belayim 1, which is the only well currently producing from this zone . . . The deep test, Belayim 113-1, was drilling ahead at about 6000 feet, having set 5059 feet of 9⅝-inch casing.

**GERMANY.** By December 15, crude production for the first time exceeded 21,201,000 barrels in one year. Total production for 1955 is expected to approximate 22,260,000 barrels, or 60,986 barrels daily . . . The German Geological Survey reports that of the 142 deep wells completed in the third quarter of 1955, 94 found oil or gas.

**INDIA:** Assam Oil Company's drilling program is continuing despite the failure of Nahorkatiya 9 and 10, drilled to 10,950 feet and 9775 feet respectively.

**ISRAEL:** Deliveries reportedly were scheduled soon on much of the $2.5 million oil drilling equipment order placed in the U. S. by Water Works Ltd. and Lapidoth Israel Petroleum Company, Ltd., both of Tel Aviv.

**JAPAN:** The new producer drilled in the Akita reportedly is a promising well . . . Total daily production is aproximately 6000 barrels for the country.

**LIBYA:** The California Asiatic Oil Company, subsidiary of Standard Oil Company of California, has acquired half interest in a 14.2-million-acre concession in Cyrenaica and Tripolitania, and plans to undertake geophysical work in the spring.

**MEXICO:** A salt dome reportedly has been located by test drilling near Cuchillo Parado, in the Ojinaga valley in Chihuahua province . . . Actual footage drilled by Petroleos Mexicanos during 1955 amounted to 1,790,353 feet, a record for the firm . . . Estimated footage to be drilled this year: 1,920,320 feet . . . Pemex is continuing its projects intended to supply western Mexico with oil and products and to avoid costly shipping through the Panama Canal: the Tampico-Reynosa pipe line, upon completion, will allow Reynosa to distribute products for the north, and plans to extend the line westward are reported . . . The Reynosa-Monterrey natural gas pipe line will be extended westward to Saltillo and thence to Torreon and Chihuahua . . . Drilling permits for the region of Yray, in the municipality of Comondú, Baja California, have been requested by Pemex; the application is being considered by the Secretariat of Mines and Petroleum Resources.

**PAKISTAN:** A contract has been awarded Pakistan Constructors for the building of a 16-inch, 188-mile natural gas pipe line from the Sui gas field to Multan. Later, the line will be extended to Lahore and will have a branch line to Kot Adu, Montgomery, Jhang and Maghiala.

**PERU:** International Petroleum Company plans to drill several wildcat tests in the Sechura desert this year . . . Skiles Oil Corporation has applied for about 500,000 acres of concessions in eastern Peru between the

upper Maranon river to the middle Urubamba region.

**PHILIPPINES:** California Asiatic Oil Company, subsidiary of Standard Oil Company of California, and Texaco Overseas Petroleum Company, subsidiary of The Texas Company, each has obtained half interest in seven exploration concessions totaling 1,235,000 acres in Cagayan valley of northern Luzon.

**RUMANIA:** Soviet Russia reportedly has sold its shares in the joint Sovrom Petrol to Rumania.

## Russia Claims 2 New Discoveries Drilled

Russia has announced two new oil discoveries at opposite ends of the "Second Baku" region between the Volga river and the Ural mountains.

The northern discovery is near the junction of the Kama and Chusovaya rivers, according to the newspaper Pravda. A test well in this Yarinsk field is said to have flowed 2470 barrels in 24 hours. "Rich" natural gas deposits in the Yarinsk area will be piped to the large nearby city of Molotvo.

Pravda also reported a large oil discovery in the southern part of the Tatar Autonomous Republic—"far from deposits already being exploited." It said that "a powerful gusher" located in the Sheshma river valley was brought in at a depth of about 3300 feet. Five more wells are being drilled in the area.

## Arab League Spokesmen Back Four Proposals

In Cairo, Arab League petroleum spokesmen have made recommendations to the member nations, as follows:

1. Arab League petroleum committee should be more adequately staffed with petroleum experts.
2. Arab oil producing countries should extend pipe lines to their Arab neighbors for mutual benefit.
3. Arab League should be granted exploration concessions and formulate a unified policy in keeping with the League's purposes.
4. Effect an oil boycott of Israel and ban any company operating in Israel from acquiring concessions in any Arab country.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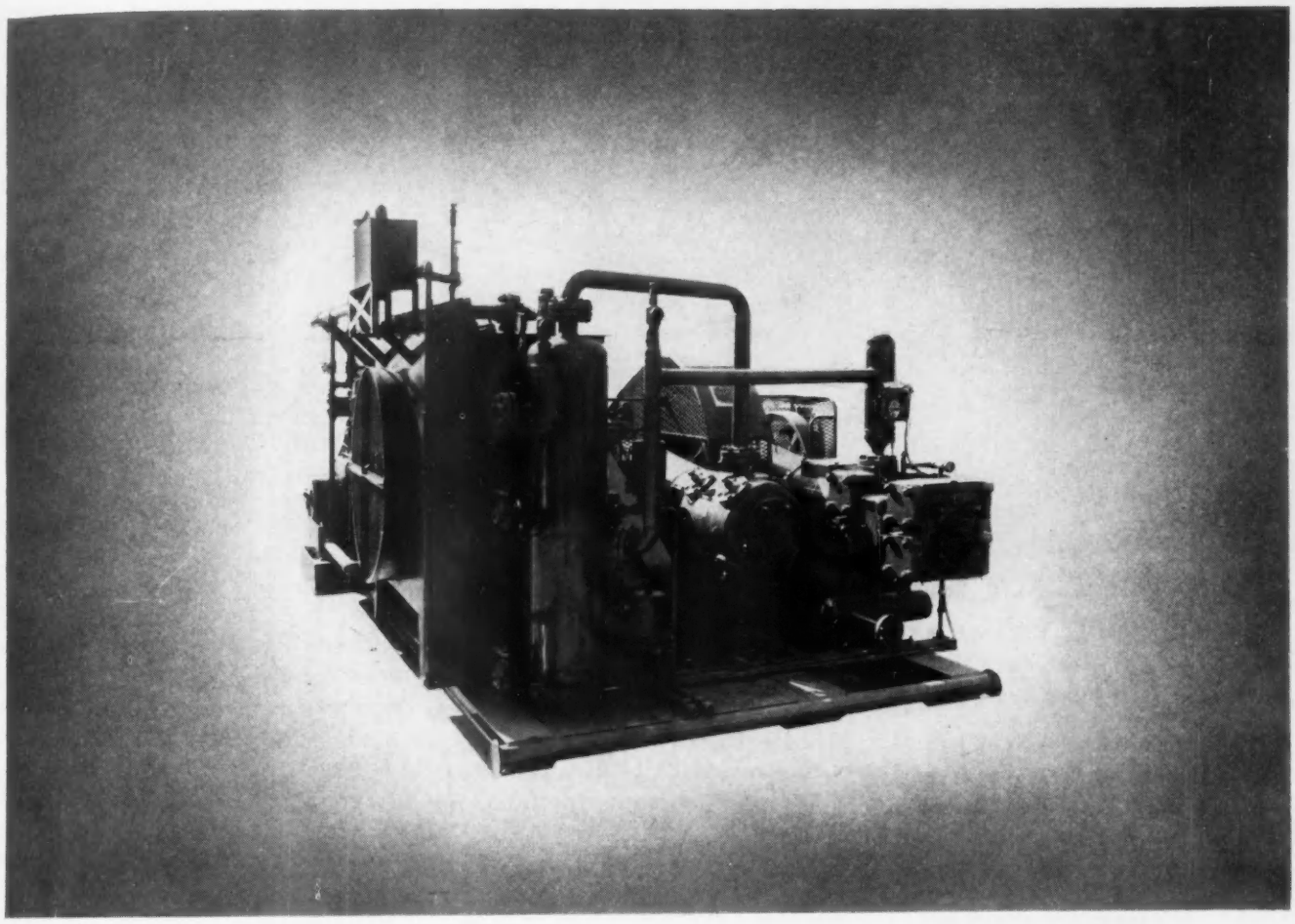

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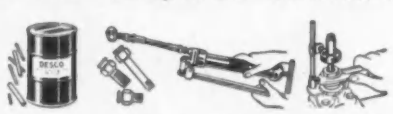


LUBRICANTS FITTINGS GUNS LUBRICATORS

Emin Iplikci, president of the Turkish Petroleum Administration, left, and John H. Maxson, chief geologist for D. D. Feldman Oil & Gas, are shown immediately after the signing of exploration permits in Turkey.

## Feldman Plans Exploration; Turkey OKs 14 Licenses

D. D. Feldman Oil & Gas is planning an expanded oil and gas prospecting program in Europe and the Middle East. Headquarters for the operations will be in Paris, where an office was established recently. The expansion abroad includes operations now under way in Turkey.

In Turkey, following publication of its new regulations on September 13, 1955, governing the petroleum law enacted in March, 1954, and modified in May, 1955, 187 applications by 12 companies were made on October 14, 1955. Of these applications, a majority were found conflicting with one another.

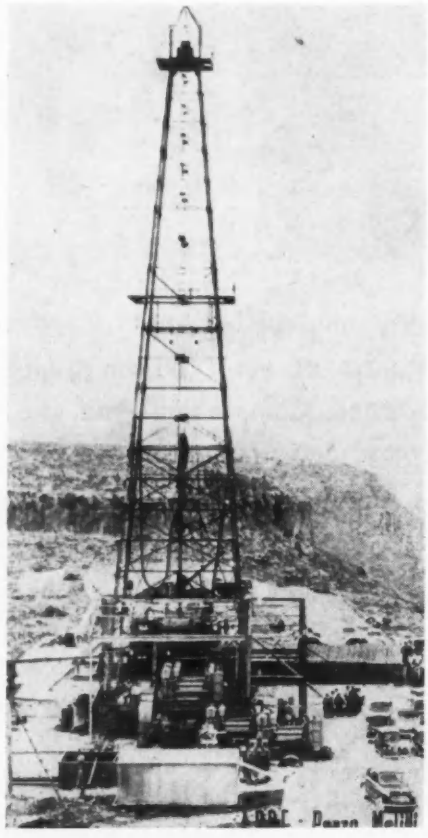
However, 14 of these applications were free from conflict, and on November 24 licenses for these areas giving the owner the exclusive right of exploration were granted by the Petroleum Administration (see Table 1).

The granted licenses cover areas mostly in the southern section of Turkey. Each license area is about 50,000 hectares (1 hectare equals 2.471 acres). Total area covered by approved licenses amounts to 700,000 hectares.

**TABLE 1**

**Companies Granted Turkish Exploration Permits**

| | No. of Permits |
|---|---|
| Esso Standard (Turkey), Inc. | 5 |
| D. D. Feldman Oil and Gas, Inc. | 3 |
| N. V. de Bataafsche Petroleum | 2 |
| Tide Water Associated Oil Co. | 2 |
| Turkiye Petrolleri Anonim O. | 2 |
| Total | 14 |



### *Arpe Drills in Sicily*

ARPE (Augusta Richerche Petrolifere, S. p.A.), a joint affiliate of Standard Oil Company, New Jersey, and RASION (Raffineria Siciliana Olii Minerali) were drilling and coring at 4848 feet in October, 1955, eight miles southwest of Augusta. This location is known as the Melilli 1 and was spudded June 27.

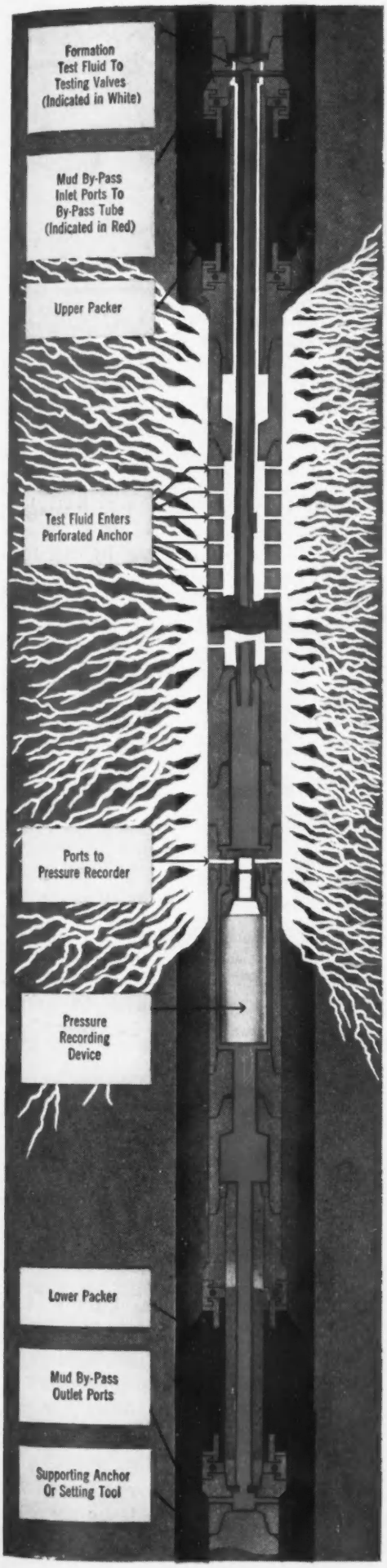
## General American Will Continue Spanish Search

General American Oil Company of Texas, heading an international group of oil investors exploring in Spain, expects to spend $10 million within the next five years on this project. This American group, and the Spanish Instituto Nacional de Industrias (INI), share expenses on a 50-50 basis, and operate jointly under the name Valdebro.

## Egyptian-American Now Known As Sahara Petroleum

Egyptian-American Oil Company, a subsidiary of Continental Oil Company operating in Egypt, has changed its name to Sahara Petroleum Company. Headquarters for the firm will continue to be in both Cairo and Alexandria.

The change in name resulted from the difficulty which Arabic-speaking nationals have in pronouncing the word "Egyptian." Egyptians call their country "Misr" instead of "Egypt." "Sahara" is a familiar Arabic word meaning "desert."


Formation Test Fluid To Testing Valves (Indicated in White)
Mud By-Pass Inlet Ports To By-Pass Tube (Indicated in Red)
Upper Packer
Test Fluid Enters Perforated Anchor
Ports to Pressure Recorder
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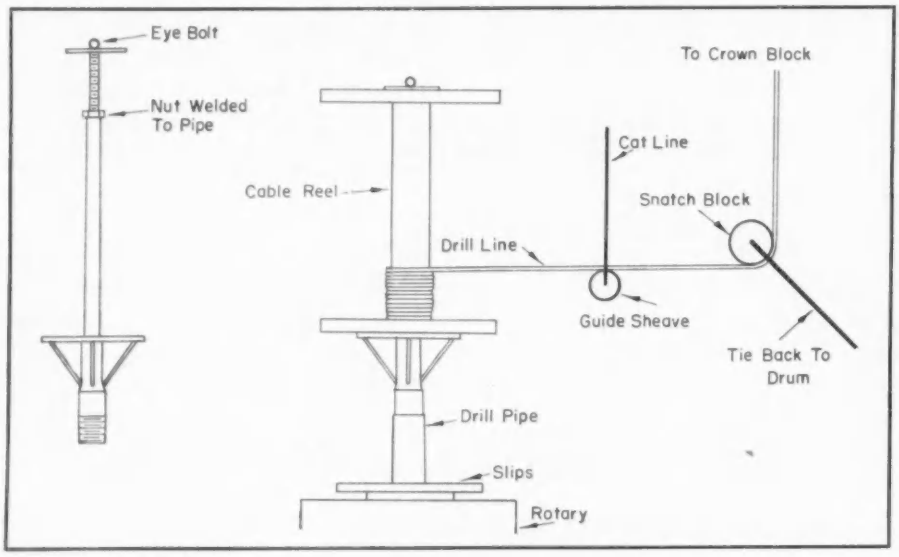


## Rig Drill Line Spool Support

The illustrated spooling device eliminates the need for reeling all of the line on the drawworks drum and then returning it to the spool; thus, considerably reduces the time required to complete the operation.

A 5-inch drill pipe section, complete with the pin end, is the major piece of equipment in the apparatus. Immediately above the pin up-set, a plate metal platform is installed and supported by four, one-inch rods welded to both the platform and the area above the pin. The size of this circular platform will be gaged by the size wire line spool most often used.

In operation, the pin is stabbed into the box of a joint of pipe, or the entire string, suspended by the slips in the rotary. Prior to making-up the pin in the box, the empty line spool is slipped over the drill pipe spooling unit and the lock nut is made-up to engage the spool securely in place. The empty spool and unit is then moved from ground level to the rotary table by hooking the cat line in the eye bolt at the top of the spooling unit.

Once the unit and spool are properly engaged, line is spooled from the drawworks to the unit by rotating the rotary. A guide sheave, activated by the cat-line, serves as a spooling guide.

Aside from speed and convenience, use of this device makes the operation of handling drill line safer.

## Elevated Fuel Tank Has Tool Rack in the Skids

When the fuel tank is elevated, a simple arrangement may be made so that the tank rests on skids which have extra sideboards to hold small tools and fittings. The skids are made from 3-inch boiler flue material and the sides are made from quarter-inch floor plate material. Plates are welded to the front and back with a center section to provide extra support and separate the bin into two compartments for tools.

A cradle for the tank is made by cutting out the center sections of the walls and running a piece of 2-inch pipe along the sides. Straps are run

over the top of the tank so that it can be removed if necessary.

When time to move, all small tools and fittings can be put into the bottom bins and the tank loaded.

## Shop-Made Rack Aids Mud Hose Handling

Transporting the bulky rubber mud hose can be a problem not only because it is unmanageable, but because care must be taken so that the hose will not be damaged.

One contractor has built a mud hose rack from scrap pipe. Equal lengths of waste or damaged pipe were cut and welded together to form the eight-sided frame. Scrap pipe also was used to brace the frame at each juncture and across the bottom.

The hose, when wound around the frame out of the way, is not apt to be torn or broken, and the complete

# "Sorry, Sam!"

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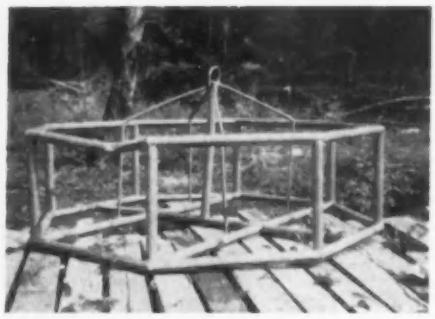
## Make Convenient Walkover from Scrap



unit can be lifted and moved conveniently by connecting a winch to the loop shown on top the center pole.

As it is almost impossible to lay out steam lines, water lines and other small pipe lines so that they are out of the way of traffic, walkovers usually are placed conveniently about the area. One type of walkover

built by a Gulf Coast contractor is made of short pieces of pipe, skid-proof sheet metal and pieces of angle iron.

The pipe forms the legs which are connected by pieces of angle iron. The sheet metal becomes the walking surface of the walkover and steps. Triangular pieces of sheet metal form step supports and give added strength to the walkover frame. All of the walkover pieces are welded together.

Brackets welded to the side of the walkover keep the water hose from coming in contact with hot steam lines.

## Simple Cook Stove Can Be Made on Rig

A handy cook stove that is simple and compact can be built on the rig from a piece of scrap pipe. A 4-inch length of pipe is used as the body of the stove. A grill set into one end provides the cooking surface and a gas jet inserted into the side of the pipe near the top provides the fuel.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**KNOW when you lose mud...**

**with "*Pit-O-Graf*"**

The Pit-O-Graf chart shows the instant lost circulation begins by recording a decrease in mud pit level. It enables action to be taken at once, while there is still time. An increase of mud in the pit, which is shown immediately on the chart, means gas or salt water. The crew has time to take action to avert a blowout. Pit-O-Graf is a completely automatic recording instrument which measures the mud pit level. With the recording unit right before the driller, he is aware at once of any increase or decrease in mud volume. Pit-O-Graf allows preventive action to be taken at once. You need Pit-O-Graf in lost circulation areas and for every wildcat.

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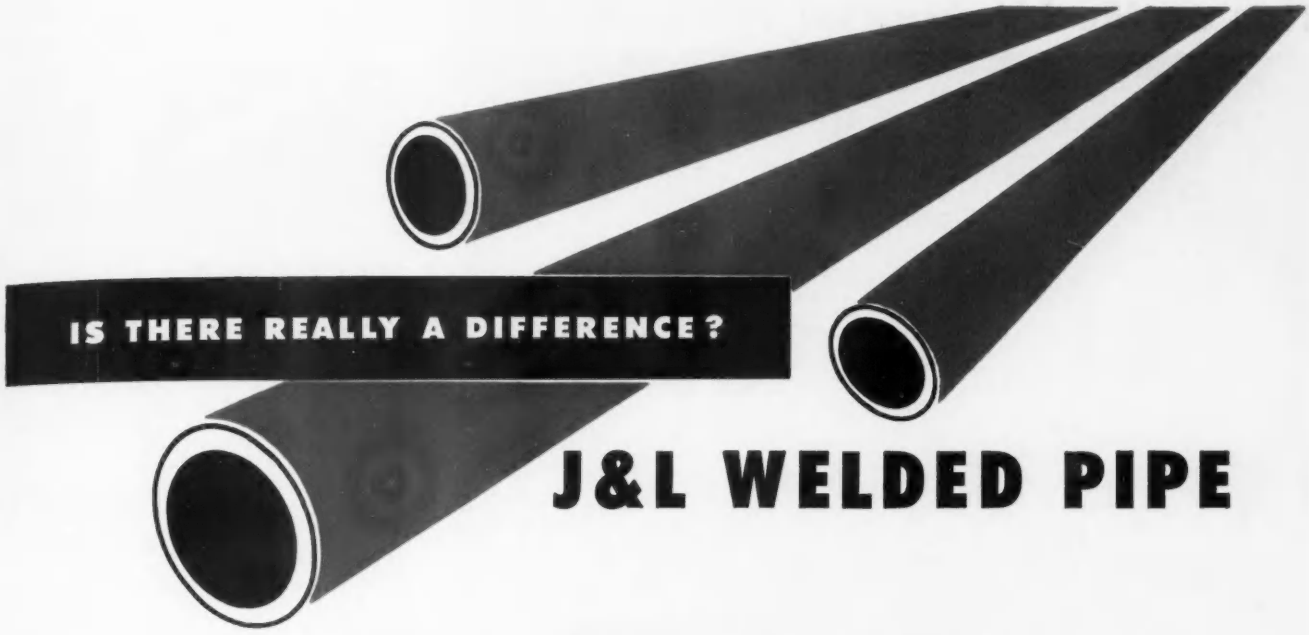
**How-To-Do-It Ideas Earn Money, too!**

**$10**—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.

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*There you have two important advantages offered you by J&L which have nothing to do with the quality of the product.*

But the quality is there, too. J&L makes every length of butt-weld and lap-weld as though it were going straight into critical service. Sometimes it does, and in such circumstances it adds to the pleasurable experience you had when you bought it. It measures up to any crisis which pipe of its kind is intended to meet.

*This is a third important advantage offered you in welded pipe by J&L.*

It is assuring to remember in buying tubular goods of any kind, butt-weld, lap-weld, electric-weld or seamless, that J&L has made things of iron and steel for more than a hundred years.

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No. 107-S

## Tips on Mud Valves for Toolpushers . .

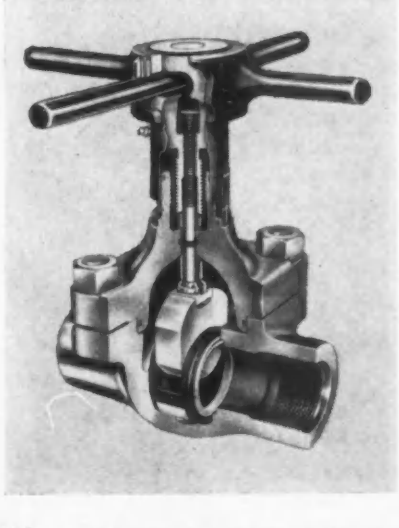
John Norman and Hank Bierman, Edward salesman, discussing MUDWONDER construction which simplifies maintenance and makes operation easy.

# MUDWONDER Cuts Operating Cost On 9 Rigs By Stopping Expensive Mud Valve Repairs

by John K. Norman, Assistant Vice-President
Schafer Drilling Company, Oklahoma City, Oklahoma

BUYING mud valves is one place we found during the past three years you can cut costs without cutting dependability or service life. On our nine rigs we replace all worn valves with Rockwell-Built MUDWONDER.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



Although the MUDWONDER is competitively priced, mud valve maintenance and repair costs have been practically eliminated under this new policy. Just recently, for example, we replaced our first parts on a two year old MUDWONDER on a mud gun.

Inspections or part replacements when necessary are quick and easy. When the bonnet has been removed, the gate slips off the stem and the one-piece seat insert lifts out of the body. Our crews can replace either of these parts while a connection is being made.

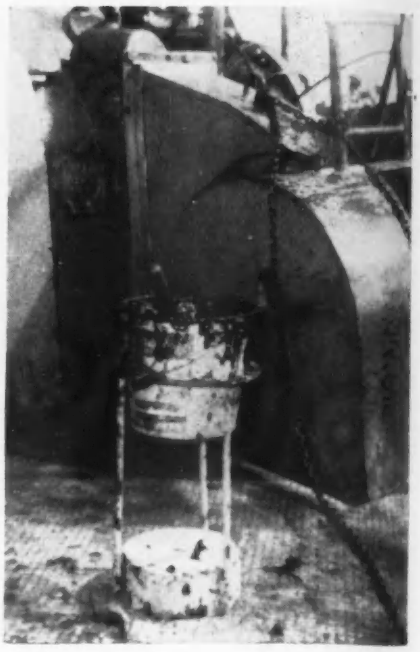
Easy operation added to simplicity of maintenance makes the MUDWONDER our best mud valve buy. We are now using them on standpipes and mud guns very satisfactorily.

I can recommend MUDWONDER to any toolpusher having mud valve trouble. MUDWONDER valves are built in 2", 3", and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 Psi WP (6000 psi test).

Your favorite oil field supply store can give you complete information, or write Edward Valves, Inc., East Chicago, Indiana. Shipments can be made from East Chicago or the Edward Houston warehouse through the supply store you select.

(Advertisement)

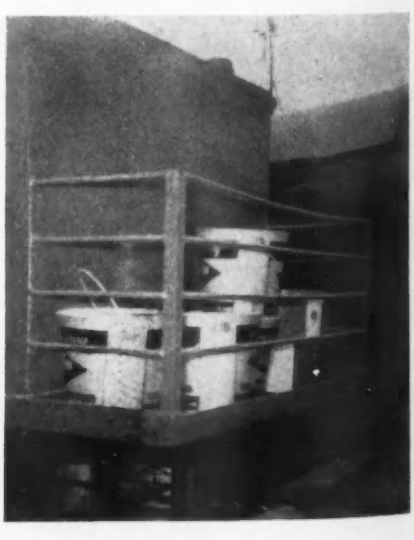
## DRILLING HINTS . . .



### Keep Pipe Dope Bucket At Working Level in Stand

Construct a convenient holder for a pipe dope bucket from sucker rods, a circular piece of steel and a large metal ring. Use the sucker rods to form the three legs for the holder; the steel to form a heavy, sturdy base; and the ring to hold the bucket.

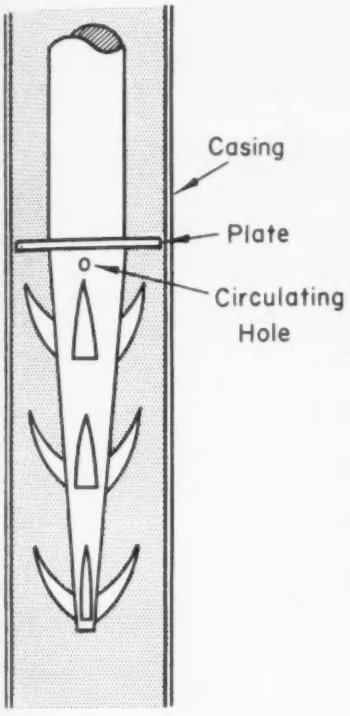
When the dope bucket is kept in this holder, it is at a convenient working level. Also, it is easy to locate and is easily and safely stored.



### Additional Storage Bins Can Be Built onto Tanks

A convenient storage place should be provided for all extra parts and materials kept around a drilling rig. This is not only a measure of good

housekeeping, but it is also a safety measure. Many times additional storage racks or bins can be built under skid-mounted tanks or fitted around them to utilize every available bit of space. One Texas contractor has used sucker rods and angle iron to build a pen type storage bin on a skid-mounted solvent tank. This type of storage bin is handy, out of the way, and keeps parts and materials from getting battered when not in use.




## Small Diameter Plate Speeds Line Fishing

When wire line is dropped in a cased hole and it is necessary to run a spear, the operation can be simplified and completed more rapidly if a plate of smaller diameter than the ID of the casing is welded to the spear assembly just above the circulating port.

With installation of this plate, it will be possible to shove the free line down the hole rather than having a part of it left above the spear. In this manner, the bunched line will be easier to grab with the spear assembly and less difficulty will be encountered on the trip out of the hole.

Since the plate is tack welded to the spear assembly, it is easy to remove the plate in the event a larger or smaller unit is required.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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

# PRODUCTION HINTS

**These How-To-Do-It Ideas Can Save You Money**

***$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.***

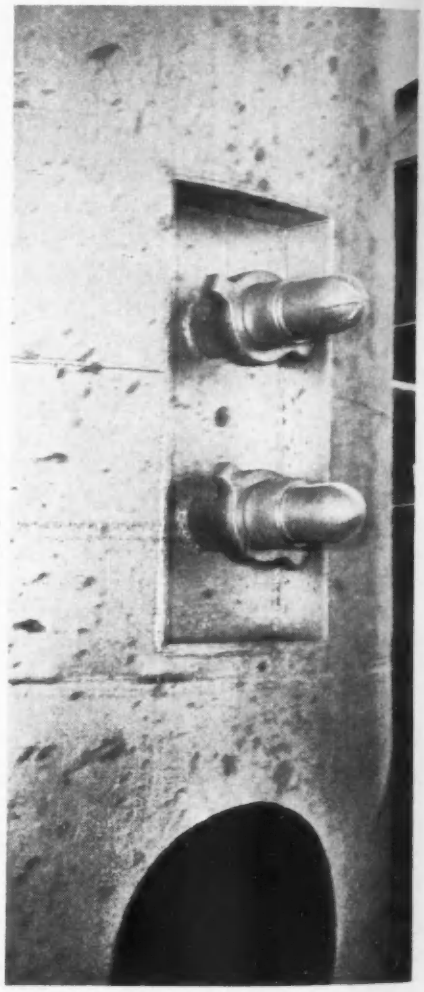
## Large Diameter Rollers Ease Low-Boy Loading

To facilitate loading and unloading heavy equipment, one company installed extra large diameter rollers on the rear of their low-boy trailers. A piece of casing was cut to size to form the roller which was supported at two points by small reinforcing rollers. This assembly takes lots of punishment and still handles the job well.

## Recess Connections on Temporary Tanks

Frequent moves of temporary or testing tanks are necessary in oil field production operations. These tanks are usually large and bulky and it is necessary to winch them up onto the tailboard of a truck or to winch them into place on a low-boy. All of the necessary inlet and outlet connections usually are in the wrong place and either in transport or in handling they eventually are bent, valves are broken or the connection is broken out of the tank.

One operator has solved this problem by recessing his connection nipples about six inches so that they do not extend beyond the tank circumference. If not required for a particular hook-up, these connections can be bull-plugged as shown. Valves or lines can be connected readily when necessary if the nipples are fitted with hammer unions.



By recessing these connections they will not be broken out if the winch line slips while transporting a tank. This not only saves on maintenance costs but every time these connections are placed under undue strain of supporting the tank weight on the winch line, the adjacent metal in the tanks is weakened, thus shortening the useful life of the tank.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- **Also can be equipped with electric motor, or gas engine drive.**
- **Made to your specifications in various sizes.**
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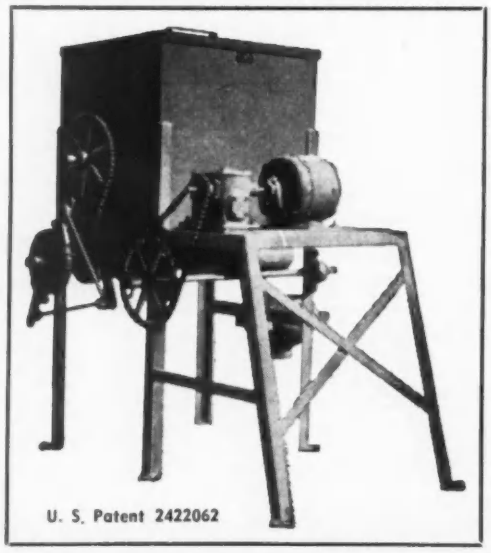

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# RIG OPERATORS...

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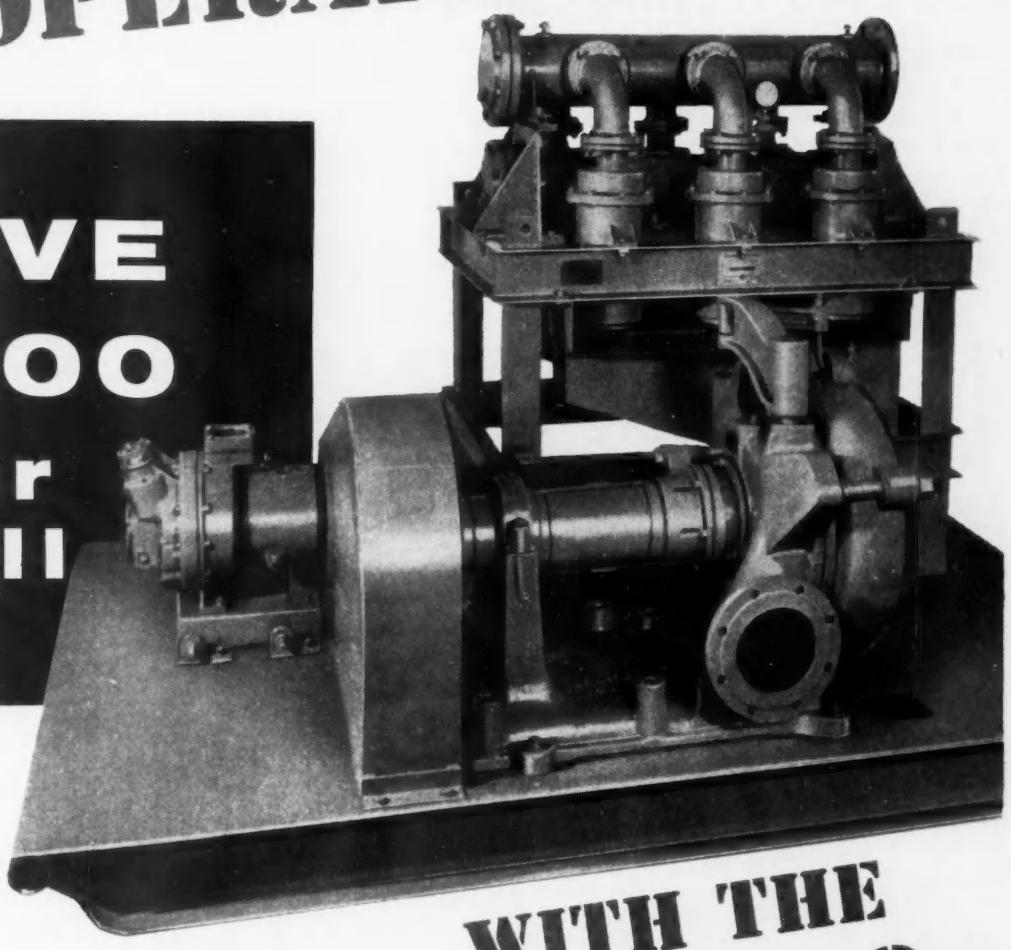

## WITH THE DORRCO D-SANDER

Sand-free rotary drill mud can mean big dollar savings. A Dorrco D-Sander on your rig will continuously return to the mud pump a mud containing less than 0.2% API sands. Here's what this means in actual savings . . .

★ Drilling and reaming time are reduced.

★ Jet bit performance is increased up to 20% with a corresponding saving in the number of round trips. Conventional bit performance is increased still greater.

★ Slush-pump maintenance costs are drastically reduced. Average life of vital pump parts is increased as much as 400%.

★ Maintenance costs on mud system are greatly reduced as a result of eliminating sand abrasion in mud lines, mud valves, and swivel washpipes.

★ Tank cleaning while drilling fast sandy holes is eliminated.

★ No sand settling in the hole means no sand bridges or tight spots . . . surface pipe runs more easily.

★ Overall rig savings average $3500. per well on existing installations!

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For more information on this important development in drilling technique write for a copy of Bulletin No. 2506. U. S. Sales Representative: Salt Water Control, Inc., 1211 Ft. Worth National Bank Building, Ft. Worth, Texas.

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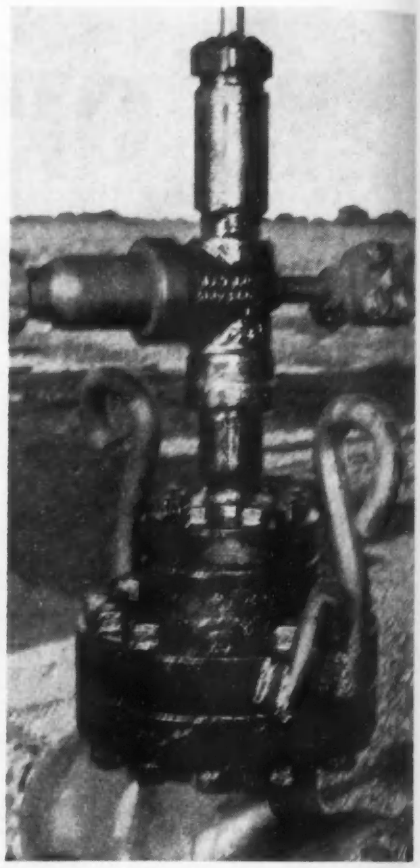
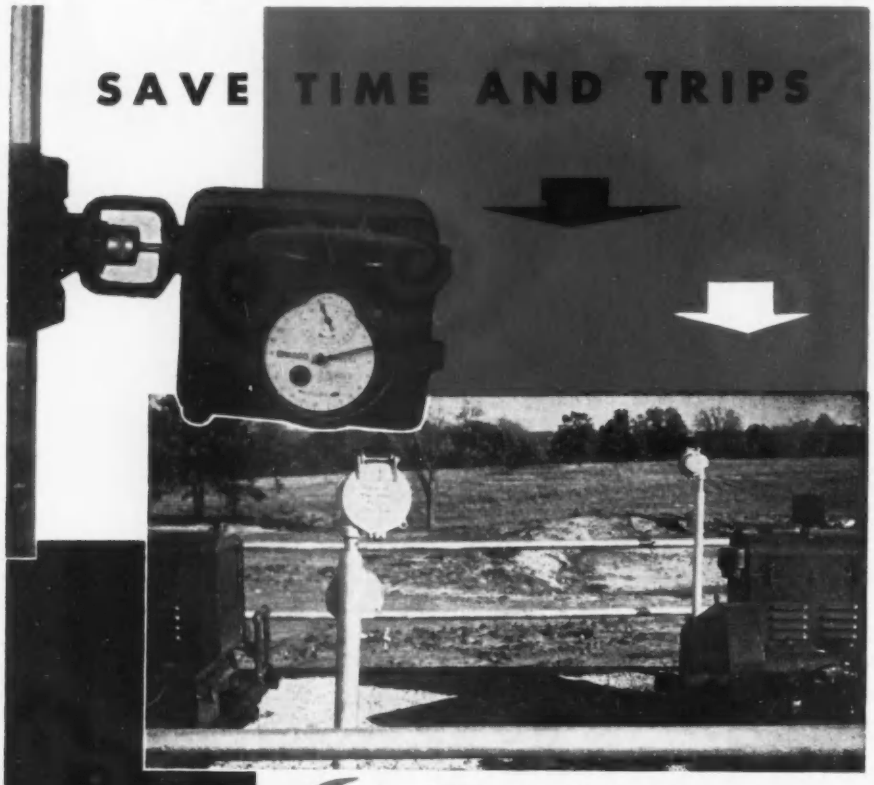
## Hooks Aid in Lifting Casing Head Flange

When clean-out or remedial operations are started on a well, it sometimes is difficult to remove the casing head flange. There are no hand holds and the flange must be lifted straight up or it will bind against the studs. Rough handling of the flange during this operation will strip the threads on the studs. If a well requires frequent pulling of the tubing, some type of aid should be provided for removing this flange.

One south Texas operator has welded hooks to the flange so that he can hook onto the elevators on the pulling line. By working the flange gently it can be raised without stripping the threads on the studs or mashing fingers. Although these hooks seem large and unsightly, they are a definite aid to operations and safety. When a well with this type of surface connection is pulled frequently, these hooks or smaller ones save considerable time in removal of the flange.




with ENARDO CLOCK SHUT-OFF VALVES and TIME CYCLE SWITCHES

The Enardo Clock Shut-off Valve is designed to control the flow of low-pressure gas or liquid and to shut off the supply at a pre-determined time. Enardo Clock Shut-off Valve fills the need for a completely automatic and dependable valve mechanism for use in gas or liquid flow lines where operating pressure does not exceed 100 lbs. This valve is particularly adaptable for use on fuel lines to engines, boilers and furnaces.

The Enardo Time Cycle Switch is designed to ground magneto on stationary engines or pumping units. They shut the engine down at a pre-determined time, "Saving time and trips." The same clock mechanism is used to operate both the Shut-off Valve and the Timer.

The Enardo Clock Shut-off Valve and Time Cycle Switches can be set to close after any number of hours up to 22 on the 24 hour Models or 11 on the 12 hour Models.

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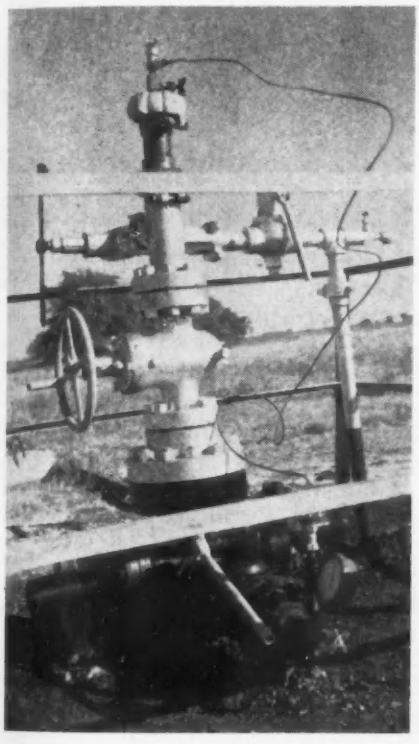
## Use Pipe and Metal Plate To Make Small Line Anchor

Anchors for blow down lines and flare lines are always a problem in swampy country. One operator made

a successful anchor by using old 2-inch pipe and some ¼-inch metal plate.

To construct such an anchor, a circular piece of ¼-inch plate 6 or 8 inches in diameter is cut with a 2⅝-inch hole in the center. One cut is made from the center hole to the outer rim and the plate is slipped over the 2-inch pipe. In this position the plate is bent in such a manner as to form an auger bit as illustrated. The plate is then welded to the pipe a few inches from the bottom of the pipe. Leaving some pipe below the auger allows the anchor to be driven into the ground for starting. Once it is started the anchor may be turned down to any depth with chain tongs.



## Tubing Replaces One Gage On High Pressure Well

On high pressure, high gas-oil ratio oil wells, it is important that the pumper keep a constant check on both tubing pressure and casing pressure. When the supply of high pressure gages ran short, one pumper merely ran a short piece of copper tubing from the tubing head to the casing head, with one needle valve near the casing head gage. When making his rounds, he could switch either the casing or tubing head into the gage and get the reading on the same gage for comparison.

In the fabulous Mid-Continent oil and gas area, Joe Roughneck does a bigger and better job year after year. Joe is the very heart of the industry . . . the composite spirit of the courageous men who invest time, money, and skill to find and produce the energy-fuels so vital to industry, national defense and the public. Joe's neighbor . . . Lone Star Steel . . . makes and delivers API casing, tubing, and line pipe for Joe's special convenience.

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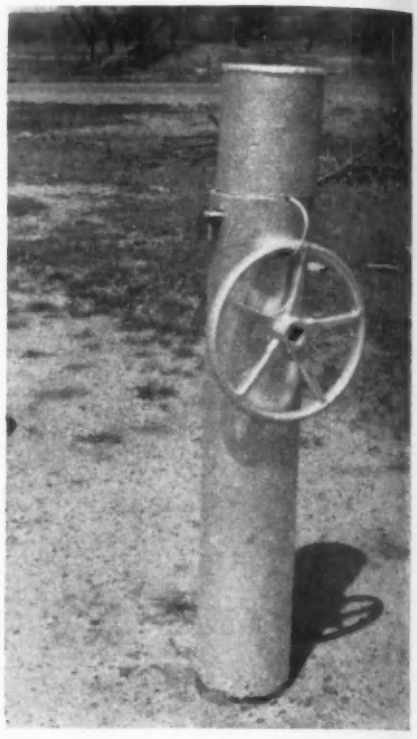
## Build Doghouse around Heater-Treater

When winter strikes operators in many fields find it necessary to protect their heater-treaters. One company solves the problem by building the doghouse for the pumper around the base of the heater-treater. This not only protects the heater but also provides the pumper with comfortable quarters.

The building is erected so that it encloses everything but the firebox and the controls. Having the controls outside makes them readily accessible and reduces danger of leakage inside the building.

To improve ignition qualities of the gas, the supply line leading to the scrubber is run through the building, allowing the gas to warm slightly before it reaches the controls. Such a system provides maximum benefits at a minimum cost.



## Extend Pipe Valve Stem For Waist High Operation

Here is a simple means of converting frequently operated valves to waist high operation. To extend the valve stem, first braze together two nuts sized to fit the gate valve stem and weld them to a rod of proper length. Grind a square on the top of the rod to fit the gate wheel. Then screw the extension on tightly and grease the gland so the stem turns smoothly.

A standpipe is made to fit over the top of the valve as shown. The gate wheel hangs on the standpipe so that it is readily accessible and the cap is locked on when the valve is not operated.

**How-To-Do-It Ideas Earn Money, too!**

**$10**—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

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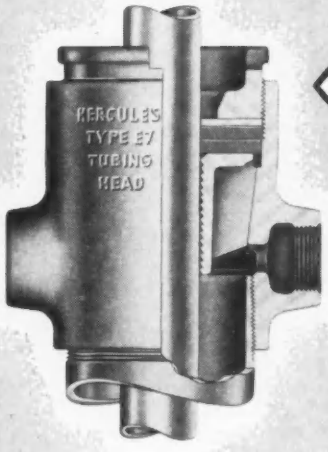
"TYPE E-5"
Available in 4½" to 5½" casing sizes to support 2" to 3" tubing. Very compact, measuring only 9½" in height. Ideal for short hook-ups on medium depth wells.

YOU GET **ECONOMY** AND **COMPACTNESS** IN THESE *NEW* HERCULES TUBING HEADS!




"TYPE E-7"
Available in 6" to 7" casing sizes to support 2" tubing to 5½" casing. Only 11" in height; will support up to 180,000 load weight.

Made of pressure cast steel for 2,000 psi test pressure. Both types are equipped with Hercules overhead packing arrangement and 3-piece self-aligning slips which are hinged to aid installation. Full opening and designed to support tubing spiders. All sizes furnished with 2" outlets.

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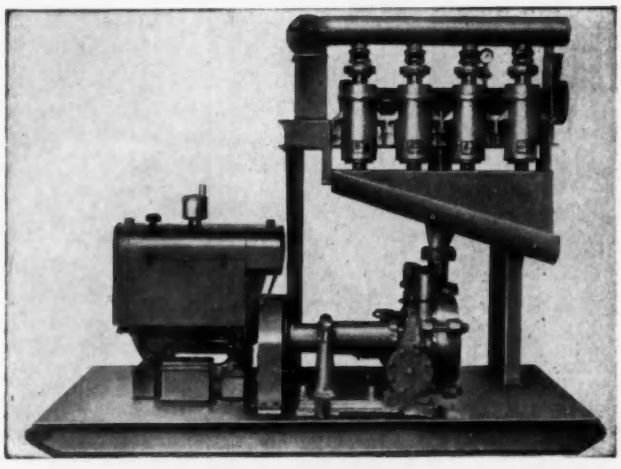

**The DORRCO MUD D-SANDER**

***A new device for removing sand and abrasive solids from drilling mud.***

- Up to 20% faster drilling
- Increases bit footage
- Greatly reduces pump maintenance
- Casing runs easier

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# What's Happening

## AMONG MEN IN THE INDUSTRY

James T. Wood

Harris T. Dodge

Frank M. Dawson

Arch W. Baucum

**The Texas Company** recently named **James T. Wood, Jr.**, vice president for the company at Los Angeles, and elected **Harris T. Dodge** and **Frank M. Dawson** vice presidents. Wood, who has been vice president in charge of foreign operations (Western Hemisphere and West Africa) since 1950, succeeds **T. H. Webb**, who retired January 1 after 33 years with the company. Dodge, general manager of foreign operations (Western Hemisphere and West Africa) since 1954, succeeds Wood as vice president in charge of the department. Dawson, who has been manager of the Purchasing department, became vice president in charge of the Supply and Distribution department. Wood joined The Texas Company in 1929 as division geologist. In 1949 he was made assistant to the president and in 1950 was elected vice president in charge of Foreign Operations (Western Hemisphere and West Africa.) Dodge was employed by The Texas Company of Mexico, Ltd., in 1920, transferring in 1922 to Texaco's Casper Works at Casper, Wyo. He has worked in various managerial capacities for the company's domestic Sales department, and in Foreign Operations for Texaco subsidiaries and affiliates in Belgium, Holland and the Philippine Islands. In 1954 he became general manager of Foreign Operations (Western Hemisphere and West Africa). Dawson joined the company in 1928 as chemist at the Port Arthur Works. From 1942 to 1945 he was refining manager of an associated company in Buenos Aires, Argentina. In 1945, he was named superintendent of Texaco's Lawrenceville Works, being named manager of the Purchasing department in 1954. **Arch W. Baucum** has been named general manager of the Foreign Operations (Western Hemisphere and West Africa) department, and **Howard S. McCray** has been named manager of the Purchasing department. Baucum was assistant to the president, having joined the company in 1934. McCray was operations manager for the Refining department. He joined Texaco in 1926.

Howard S. McCray

•

**Hal R. Adams**, formerly division geophysicist of **Sohio Petroleum Company**, has been promoted to division exploration manager of the Northwest division. He will report to the division manager and will be directly responsible for all geological, geophysical and land functions of the division.

•

**Ralph O. Dietler**, chairman of the board of directors of **Stanolind Oil Purchasing Company**, retired from active service January 1. He served 37 years with Standard Oil Company (Indiana) affiliates, entering the oil business in 1919 with Midwest Refining Company in which the Indiana company acquired a controlling interest. He joined Stanolind Crude Oil Purchasing Company, now Stanolind Oil Purchasing, in 1931 and was made president of the company in 1940. He was elected chairman of the board in 1948.

**Doyle McClennen** has been appointed regional petroleum engineer of **Plymouth Oil Company** at Midland, Texas, in charge of petroleum engineering activities for West Texas and New Mexico. He resigned as petroleum engineer with Stanolind Oil & Gas Company in Fort Worth to accept the new position.

•

**Roy B. Bryant**, chief electrical engineer for **General Petroleum Corporation**, retired from the company January 1 after more than 37 years of service. Bryant joined the company in 1918 as electrical engineer for the Engineering department and has held the post continuously since that time. Early in the 1920's Bryant went to Mexico with a General Petroleum exploration group. He set up radio communications between the company's headquarters and various drilling camps throughout the area being explored. This was one of the first known company radio communications systems.

•

**H. W. Penterman**, executive assistant to W. A. Alexander, vice president of **Shell Oil Company's** Denver area, retired January 1 after nearly 37 years with the company. Penterman joined Shell as a roustabout in 1919 at Drumright, Okla. In 1936 he was named land manager for the Tulsa area, which position he held until 1944 when he was appointed executive assistant to the vice president. He transferred to Denver a year ago as executive assistant to the vice president to assist in organization of the newly-formed area.

H. W. Penterman

•

**Robert O. Lewers** has been appointed division general attorney for **Sun Oil Company's** Rocky Mountain division. Joining Sun in 1951 in the Title Records department, he was made attorney in 1952. He was with the Denver County Court prior to his Sun employment.

•

**Ralph A. Cuthbertson**, now treasurer of **Cities Service Oil Company (Pa.)**, succeeds **Walter W. Martin**, who is retiring after 52 years with the company, the last 22 years as treasurer. Cuthbertson has been with Cities Service 35 years. He joined the company as a bookkeeper in Cleveland in 1920 and has been secretary the past 12 years. He will be succeeded as secretary by **James W. Fry**, an employe of Cities Service since 1926 and office manager of the Philadelphia region since 1950. Martin began his career with Cities Service in 1903 as an accountant for Denver Gas and Electric Company, then a subsidiary. He served in various capacities with several other subsidiaries in Colorado, Texas, Ohio, Pennsylvania and other states before going to New York in 1933 as treasurer of Cities Service Oil Company (Pa.).


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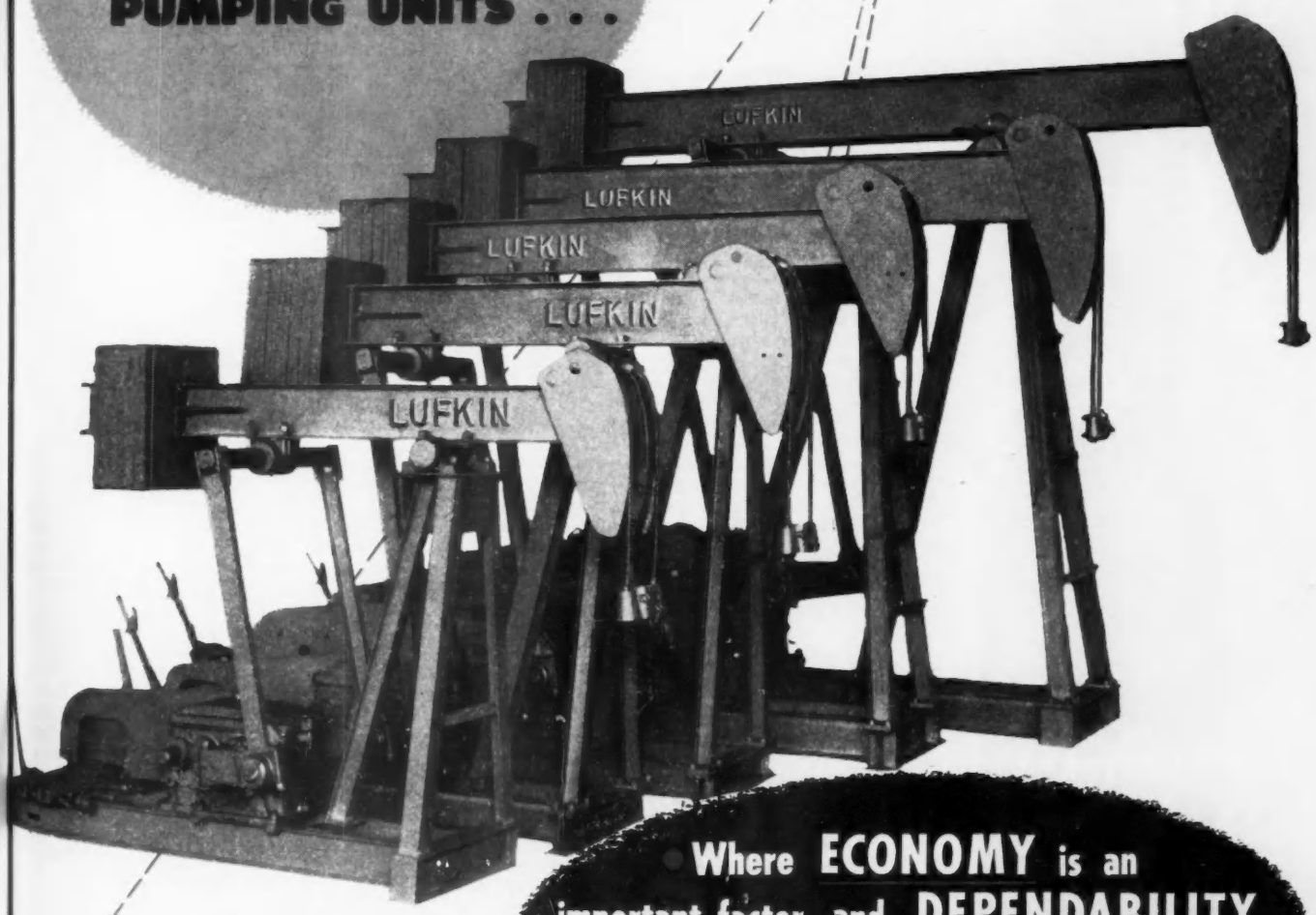


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A. L. Burns

Tom W. Nelson

**A. L. Burns**, who recently observed his thirty-fifth anniversary with **Gulf Publishing Company**, has relinquished his duties as vice president and general manager of the company to devote full time to the Gulf Printing Company of which he has been president two years. **Tom W. Nelson**, vice president of Gulf Publishing Company, who began with the company in 1922 as an office boy, has been named executive vice president and general manager of the company. **Robert deSombre**, director of the Circulation department, has been appointed assistant general manager of Gulf Publishing. He also was elected vice president. Burns will continue as a member of the board of directors of Gulf Publishing Company and will be a member of the Advisory Committee. Gulf Publishing Company publishes WORLD OIL, THE COMPOSITE CATALOG for the drilling-producing industry, PETROLEUM REFINER, THE REFINER CATALOG and PIPE LINE INDUSTRY. Gulf Printing Company is an affiliate company. **Ray L. Dudley** remains president of Gulf Publishing and chairman of the board of Gulf Printing.

Robert deSombre

•

**Seaboard Oil Company** announces the appointment of **H. C. McCarver** as assistant vice president and assistant general manager. McCarver was manager of the geological and geophysical departments of the Mid-Continent division prior to his new appointment.

•

**Continental Oil Company's** Rocky Mountain region exploration department has announced the following staff changes: **A. W. Black**, Billings, Mont., division geophysicist, promoted to assistant regional geophysicist with headquarters in Denver; **E. J. Grivetti**, Billings, geophysical supervisor, promoted to division geophysicist at Billings, succeeding Black; and **John W. Strickland**, Denver, research geologist, promoted to assistant division geologist, with headquarters at Casper, Wyo. Black joined Conoco in 1944 and served on geophysical crews in the Rocky Mountain area before being named geophysical supervisor at Denver in 1948. He has been division geophysicist at Billings since 1952. Grivetti became associated with Conoco in 1948. He held various positions on geophysical crews before his promotion to supervisor at Billings in 1955. Strickland joined the company in 1951 as a research geologist at Denver. Previously, he was with other oil companies as petroleum geologist and consultant.

**Humble Oil & Refining Company** recently announced the following changes in Production department supervisory personnel: **James A. Capeheart**, Grand Isle district, Louisiana division, was promoted from part-time driller to rotary driller at Grand Isle. **R. G. Condra**, part-time driller in the McCamey district, West Texas division, was promoted to rotary driller at Grand Isle. **P. E. Condra, L. B. Watson** and **J. L. Cole**, rotary drillers, Grand Isle district, were promoted to toolpushers. **J. S. Daniel**, rotary driller, Bayou Sale district, Louisiana division, was promoted to toolpusher at Potash, Louisiana division, and **J. H. Reece**, rotary driller, Grand Isle district, moved to Sugar Valley district, Gulf Coast division, as rotary driller. **Marion M. Martin**, assistant district chief clerk, transferred from the North Katy district, Gulf Coast division to the Stratton district, Southwest Texas division, as assistant district chief clerk. **Jesse E. Heller**, civil engineer, Tyler division office, was transferred to the Civil Engineering division, Houston, as civil engineer.

•

**Joseph R. Mares** announces that **Henry Groppe** is associated with him as an industrial chemical consultant with offices in the Commerce building, Houston. Groppe formerly was with Dow Chemical Company in Michigan and Freeport, Texas, with The Texas Company at Lawrenceville, Ill., and with the Arabian American Oil Company in Saudi Arabia as assistant to the manager of refining. In 1950 he joined Monsanto Chemical Company at Texas City, Texas, later becoming assistant director of development for the Plastics division, his position prior to entering the consulting field.

•

**Dr. Gordon Rittenhouse** has been named manager of the Geological department of **Shell Development Company's** Exploration and Production Research division in Houston. Since organization of Shell's Denver area in 1954, he has been located there as coordinator of special geological studies. Rittenhouse succeeds **Rufus J. LeBlanc**, who joined the staff of Exploration Technical Services of Shell Oil to devote full time to stratigraphic investigation of the Texas-Louisiana coastal and offshore region. **Sherwood Buckstaff**, formerly exploration manager of the Houston area, will work with LeBlanc in this geological study of the Gulf of Mexico.

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George Koegler

E. F. Johnson

**Standard Oil Company** (New Jersey) recently appointed **George Koegler**, now executive assistant to the chairman of the board, as deputy general counsel of the company, succeeding **E. F. Johnson** who will retire this year on completion of 30 years service to resume general law practice. Before joining the Jersey Standard Legal department in 1943, Koegler was a member of the New York law firm of Kellogg, Emery & Inness-Brown and its successor, Satterlee, Warfield & Stephens. Johnson first joined the legal staff of Standard Oil Company (New Jersey) in 1926, although he was retained by them in 1922 to supervise legal interests in the southern marketing territory of what is now Esso Standard Oil Company. In 1923 he was senior partner in the law firm of Johnson & Adams, resigning three years later to join the legal staff of the Jersey Company. He was appointed general attorney in 1941 and became general counsel in 1945.

•

**Roy B. Ralston** has been named manager of the Evansville, Ind., division of **Phillips Petroleum Company's** land and geological department. He joined the company after 15 years in land, geological and production work in the Evansville area. He is a member of the American Association of Petroleum Geologists, the American Geological Society, and the Illinois Basin chapter of the American Petroleum Institute.

•

**Albert Gregersen**, appointed staff representative for the Eastern Hemisphere Production department, **Gulf Oil Corporation**, will serve as the Pittsburgh general office representative for the vice president of the department, C. W. Hamilton, who is stationed in London, England. Acting for Hamilton in many matters, including representing him on the company's Production Council and the president's Coordination Council, Gregerson will expedite liaison and coordination between the senior vice president, production, and the production office in London. A veteran with Gulf, Gregerson has had many years' experience as a practicing geologist.

Albert Gregersen

•

**Odom Fanning** has been appointed manager, Information Services, **Midwest Research Institute**, Kansas City, Mo. Prior to his appointment, he was in charge of the publication services of the Georgia Tech Engineering Experiment Station and editor of the Station's magazine, **The Research Engineer**.

**John E. Buckley** has been promoted to assistant division superintendent for the Mid-Continent division, **Sohio Petroleum Company**. District superintendents of the Kansas, Centralia, and WEHLU districts will report directly to Buckley. He will continue to report to **J. H. Field**, division superintendent for the Mid-Continent division.

•

**Stanolind Oil and Gas Company** recently named **F. L. Nelson**, former assistant Gulf Coast division engineer, field superintendent of the company's Luby area near Corpus Christi, Texas. He was replaced by **M. Scott Kraemer**, who was promoted from Houston district engineer. **Jack McWilliams**, former senior petroleum engineer, was promoted to Houston district engineer. Nelson joined Stanolind in 1937 as a roustabout in the South Houston field. Kraemer joined Stanolind in 1943 as an apprentice engineer in the North Cowden area near Odessa, Texas. McWilliams joined the company in 1942 as a roustabout at Woodsboro, Texas.

•

**Emil V. Hegyi's** election as president and a director of **Reiter-Foster Oil Corporation** has been announced. **John H. Van Kirk**, former president of the corporation, will continue to serve on the board of directors. Hegyi, who assumed his duties January 1, was formerly assistant to the president of U. S. Freight Company, prior to which he served as vice president of the American Institute of Management.

Emil V. Hegyi

•

**Aaron Wachter, Shell Development Company**, has been given the 1955 Outstanding Service Award of Western region, National Association of Corrosion Engineers. Dr. Wachter, immediate past president of NACE and long active in the association in administrative and technical capacities, received the award at Western region's fifth annual corrosion conference banquet.

•

**Thomas D. Durrance**, who has joined the public relations staff of **The Texas Company**, will be located in the company's New York headquarters. For the past year he has been associate editor of *Barron's Business and Financial Weekly*. His previous career includes service as Washington and European correspondent for *Time*, senior editor of *Kiplinger Magazine*, and information specialist with the government's overseas aid program.

•

**Phillips Petroleum Company** has announced two division office personnel changes in its land and geological department. **J. E. Downey** has been named assistant division manager and division landman in the Calgary, Alberta, Canada, office, replacing **L. M. Spleth** who became division landman of the Denver division. Downey joined Phillips Refining department in 1942. He later transferred to the land and geological department where he served in clerical capacities and as assistant to various division and regional managers. Spleth, formerly assistant division manager and division landman in Calgary, joined Phillips in 1945.


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R. G. Kurtz

R. R. Simonson

**R. G. Kurtz**, formerly Los Angeles division geologist of the **Ohio Oil Company**, is now on special geologic assignment, with **R. R. Simonson**, geologist at Los Angeles, succeeding him. A veteran of 28 years' geologic experience with Ohio Oil, Kurtz joined the company at Casper, Wyo., transferring to Marshall, Ill., in 1936. He was appointed district geologist at San Antonio, Texas, in 1948 and Los Angeles division geologist in 1953. Simonson has been a member of Ohio Oil's geologic staff at Los Angeles since 1942.

•

**Don W. Woods**, director and general counsel of **General Petroleum Corporation**, has ended an active career in the West Coast petroleum industry which covered a span of nearly 40 years. His official retirement date from General Petroleum is April 1, 1956. Woods, who was named a director and general counsel for General Petroleum in 1946, joined the company in 1916 to investigate an oil land controversy. He became secretary of General Petroleum Corporation in 1932.

•

**Standard Oil Company of California** has announced that **George J. O'Brien** has been placed in charge of the company's conservation activities and relationship with governmental agencies. O'Brien, a vice president, has been general representative for the company in Southern California for the last 14 years. He recently was elected president of the Huntington Beach Company.

George J. O'Brien

•

**William W. Walmsley's** appointment as assistant division manager of **Sun Oil Company's** Rocky Mountain division has been announced. He first joined Sun in 1951 as district landman at Billings, Mont., and was made agent and attorney-in-fact early in 1955. Before joining Sun, Walmsley was scout for Standard Oil Company of Texas and a landman for Seaboard. **William S. Woods, Jr.**, now manager of a newly-created finance and corporate stock division of Sun's treasury department, will be responsible for case receipts and disbursements, maintenance of the company's bank accounts, and record keeping with respect to common and preferred stock. A certified public accountant, Woods joined Sun as a senior auditor in 1947. He was an instructor in accounting at the University of Pennsylvania from 1945 to 1947.

**Robert B. Bossler**, formerly director of the Pennsylvania Grade Crude Oil Association, has been named professor of petroleum engineering at Texas A&M College. His principal courses will be in valuation and secondary recovery. Bossler has been a petroleum engineer with Johnson, Huntley and Sommers, consulting firm, Chemical Oil and Gas Company in West Virginia, Pennsylvania Petroleum Company and Brundred Oil Corporation. In 1954 he was named director of the Pennsylvania Grade Crude Oil Association, a research organization directed to prolonging life of oil fields by improving recovery methods.


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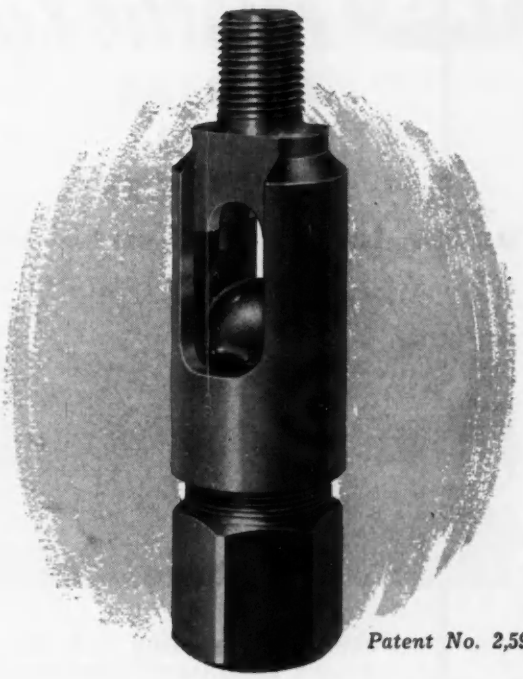

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Castle J. Harvey

Paul C. Reed

**Castle J. Harvey**, head of **Texas Pacific Coal and Oil Company**'s geophysical department since 1953, became assistant manager of exploration January 1. **Paul C. Reed** of Midland succeeded him as TP's chief geophysicist. Harvey has been active in oil exploration since 1933. His experience includes service with Amerada Petroleum Corporation, Atlantic Refining Company and Deep Rock Oil Corporation. Reed has been a geophysicist for Forest Oil Corporation in Midland five years. Prior to that time he served with Carr Geophysical Company, Century Geophysical Corporation, and was active in geophysics and exploration for Gulf Research and Development Company 16 years.

•

**T. M. Rodgers** and **J. A. Seglund** now have an oil and gas exploration and development consulting practice in New Orleans. Rodgers, who formerly was with The Texas Company in the Louisiana division, was supervisor for the Reservoir Engineering section and later served in the Legal-Engineering section. Seglund has worked in south and north Louisiana as well as Arkansas and was district geologist for Texaco in the Shreveport and Lafayette offices.

**Almer F. Childers**, newly-appointed executive vice president of **Toklan Oil Corporation**, will be in charge of expansion of the Tulsa firm's activities. Also a director of the company, Childers served 23 years with Gulf Oil Corporation, resigning in 1951 as staff geologist in charge of joint operations to become a consultant. Cecil Hagen, president of Toklan, was one of his first clients. His association with Hagen later became permanent as an appraiser of properties. Childers was elected a director of Toklan in June, 1955.

•

**Edgar W. Jenkins**, Jr., has been named communications engineer of **Shell Oil Company's** Midland area.

Edgar W. Jenkins

In handling the duties of the newly-established staff position, he will coordinate and assist all departments in planning and engineering facilities that best provide effective means for transmitting and receiving company internal information. Jenkins started with the company in 1949 as an assistant operator in offshore exploration work at Houston. In 1952 he was assigned to Shell Caribbean Petroleum Company serving as communications supervisor during construction of a pipe line in Venezuela. In 1953 he was transferred to Midland as a mechanical engineer.

•

**Donald L. Dickerson** has been appointed patent counsel of **Socony Mobil Oil Company, Inc.**, succeeding **Dallas R. Lamont**, recently elected to the company's board of directors. Dickerson, who has been assistant patent counsel since 1943, will be in charge of the Patent division of the Law department. He first went to work in the laboratory organization of Socony Mobil's West Coast affiliate, General Petroleum Corporation, in Los Angeles in 1925. Leaving the company in 1927, he entered the private patent law firm of Frank L. A. Graham. In 1937, he joined Socony Mobil in New York City as a member of the Patent division.

•

**J. H. Beach** and **Victor Church**, formerly with The Oceanic Oil Company, entered independent petroleum exploration January 1. Both will continue as geological consulatants for Oceanic, however, in those areas where the company presently is drilling exploratory wells.

•

**Sun Oil Company** announces retirement of three veteran Toledo executives with a combined service total of more than 127 years. Completing active duty with the company are: **H. O. Cameron**, assistant secretary and assistant to the vice presidents in charge of manufacturing and production who started his Sun service in 1904; **J. J. Martin**, secretary-treasurer of the Bay Terminal Railroad who observed his fortieth Sun anniversary in November, 1955; and **Robert E. Fowler**, Sun's assistant traffic manager in the Toledo area who marked 36 years' service with Sun in 1955. Cameron, who was president of the Bay Terminal Railroad from 1925 until the line's dissolution in 1955, also is a former manager of Sun's Toledo and Yale, Okla., refineries. He was manager of the company's Michigan Production division from 1925 to 1954.


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# DEATHS

**W. N. Finnegan, Jr.**, 59, prominent figure in oil industry affairs for more than 35 years, died in Houston December 28. Beginning his oil career with The Texas Company, Finnegan later resigned, joining Humble Oil & Refining Company in 1919. In his 35 years with Humble, he rose to the post of executive assistant in charge of press relations. In his last years with Humble he also was chairman of Humble's press relations committee.

**James Evans Douglas**, 54, independent oil operator and drilling contractor, died in Houston December 16. A member of Nomads, Mid-Continent Oil & Gas Association and Texas Independent and Producers Royalty Owners, he spent 18 years in Mexico with Standard Oil Company (New Jersey).

**Paul Huber Reisher**, 64, retired chief geologist for Gulf Oil Corporation, died in Tulsa December 22. He retired in 1954 after 42 years with Gulf. He was a founder of the American Geological Institute.

**Dr. Laurence F. Athy**, 57, former manager of Continental Oil Company's Exploration department, died December 17. Joining Conoco as geologist in 1925, he became manager of the Geophysical division in 1948 and manager of exploration in 1951. He retired early in 1955.

**Marshall L. Hough**, 56, president of Darling Valve & Manufacturing Company, died December 7. President and treasurer of Darling Valve for the past 20 years, he joined the company as a draftsman in 1921.

**Walter D. George**, 76, pioneer oil man and past president of the Louisiana-Arkansas division of the Mid-Continent Oil & Gas Association, died recently at Shreveport, La. He began his oil career at Spindletop in Texas in 1901.

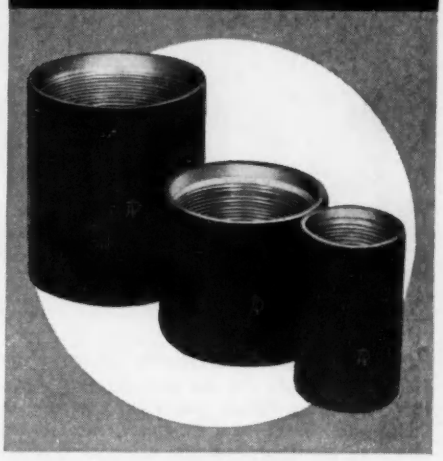
**W. R. Martin**, 82, founder of the Martin-Decker Corporation, died recently in Long Beach, Calif. He retired from the company in 1946 after a long career in industry and with the Long Beach Board of Harbor Commissioners.

**Alpheus J. Mercer**, 95, pioneer oilman, died in Fort Worth November 28. Driller of the well that opened the Kossut oil pool in Auglaize County, Penn., he also sold the first lease at Sistersville, W. Va., to John J. Carter, founder of Carter Oil Company. He had the King Ranch under lease around 1900.

**Dr. Emory N. Kemler**, 51, nationally-known mechanical engineer, died December 6 in Minneapolis, Minn. Head of the division of mechanical engineering at the University of Minnesota, he, at one time, had been chief production engineer of the Tulsa division of Gulf Oil Company. He resigned from Gulf in 1940 to accept a position on the engineering staff of Purdue University.

**Guy L. Ayling**, 81, died recently in Borger, Texas. He was in the independent oil business in Bartlesville, Okla., until his retirement in 1939.


# ALL COUPLINGS for the oil industry



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# What's Happening

## AMONG INDUSTRY ASSOCIATIONS

### *Permian Basin Oilmen Head Society*

**From left to right are the newly-elected officers of the Permian Basin Geophysical Society for 1956: R. Maxey Pinson, Union Oil Company of California, first vice president; W. A. Seal, Jr., Continental Geophysical Company, second vice president; Decker Dawson, Dawson Geophysical Company, president; Malcolm A. Knock, Stanolind Oil & Gas Company, secretary; and R. J. Knott, Atlantic Refining Company, treasurer.**

### Mineral Law Foundation Formed in Rockies Area

Organized and operated for educational and civic purposes connected with elevation of the legal profession and the stimulation of research and discussion of mineral law problems, the Rocky Mountain Mineral Law Foundation recently was incorporated as a non-profit corporation. With its principal office at the University of Colorado School of Law, the foundation grew out of the first annual Rocky Mountain Mineral Law Institute held at the university last year. More than 600 persons from 23 states attended the institute.

The foundation will establish and operate legal institutes and will engage in other related activities. Research and investigations of legal and related industrial problems will be made. Also, recommendations to bar associations, oil and gas associations, mining associations, foundations and other institutions interested will be made. Scholarships and fellowships will be encouraged, and studies, reports, proceedings and papers will be prepared and published.

The 11 members of the foundation are the law schools of the University of Denver, University of Montana, the universities of Wyoming, South Dakota and Colorado, the Colorado, Montana, Nebraska and South Dakota Bar Associations, the Colorado Mining Association and the Rocky Mountain Oil and Gas Association.

On the board of trustees are Edward C. King, dean of the University of Colorado School of Law; Harold H. Healy, president of the Rocky Mountain Oil and Gas Association; Robert S. Palmer, executive vice president of the Colorado Mining Association; and Thomas K. Younge, president of the Colorado Bar Association.

Arthur Thad Smith, Continental Oil Company, is newly-elected president of the board of trustees; William J. Wehrli, representing Rocky Mountain Oil and Gas Association, is vice president; Clyde O. Martz, professor of law at the University of Colorado, is executive secretary; and Howard Gullickson, Shell Oil Company, Denver, is treasurer.

### *Petroleum Production Pioneers Honor Member*

**The board of directors of Petroleum Production Pioneers recently presented C. E. (Dad) Wilcox, pioneer designer and inventor of oil tools, with a life membership in the organization. Witnessing the presentation were, left to right, standing: Frank Seaver, R. T. Harcus, Tom Selser, Lin Little, Ed Stearns, Bill Todd, C. J. McLaren and Tom Hickey. Sitting are Don Pinnell, P. P. P. president, and Wilcox. Highlighting Wilcox's career was his invention of the kelly and the square bushing with tapered bowl that permits wedge slips to be inserted for gripping the pipe. He also has been responsible for development of tongs, elevators, underreamers and other tools now in wide use.**

### Photogrammetry Groups Schedule Convention

The Shoreham Hotel in Washington, D. C., will be headquarters March 18-24 for consecutive meetings and co-exhibit of the American Society of Photogrammetry and American Congress on Surveying and Mapping. Modern mapping and surveying techniques and applications will be principal topics of the joint convention.

Meetings will be open to non-members, particularly mineral and petroleum prospectors, leasehold boundry and title men, geologists, geophysicists, electronicists, economists, project engineers, land evaluators and investment engineers.

### New Officers Announced By Wyoming Geologists

John Partridge, consultant, recently was named president of the Wyoming Geological Society, with Earl West, consultant, and Jim Barlow, Forest Oil Company, serving with him as vice presidents. Ann Stanley, Atlantic Refining Company, was elected secretary, and Wayne Blackman, Stanolind Oil and Gas Company, treasurer.

### API's OIIC Announces Field Organization Changes

Appointment of John F. Campbell as field director for the Oil Industry Information Committee of the American Petroleum Institute has been announced. Formerly Midwest regional director for the industry-wide public relations program, Campbell also has served as district representative in the Boston and Chicago offices.

J. W. Lenon, senior district representative in the Kentucky-Ohio-Tennessee district office in Cincinnati, has been appointed Campbell's successor in Chicago. John Richardson, of the Cincinnati office, has been named to the Lenon vacancy.

Other changes in the field organization are: H. S. Phillips, of the New York district office, transferred to Chicago; F. D. Rogers, Jr., added to the New York district office staff; C. D. Everhart, of the New Orleans office, promoted to the Philadelphia office as senior district representative; and R. W. Fuehrer, of Canton, Ohio, added to the Philadelphia staff.

John H. Francis has been added to the Atlanta staff; B. B. Thompson, Denver, has been promoted to the Chicago office as senior district representative; A. C. Rose, of Tulsa, has been transferred to the New Orleans office; and Robert B. Bizal has been added to the Tulsa staff.

Joe T. Dickerson, president of Shell Pipe Line Corporation, succeeds Roy M. Stephens as chairman of the six-state Gulf-Southwest district Oil Industry Information Committee. He will lead 4000 oil men and women in Alabama, Arkansas, Louisiana, Mississippi, New Mexico and Texas now serving on 72 area and 546 community committees.

E. A. Williford is new chairman of the Texas Oil Industry Information Committee and is a member of the six-state executive committee.

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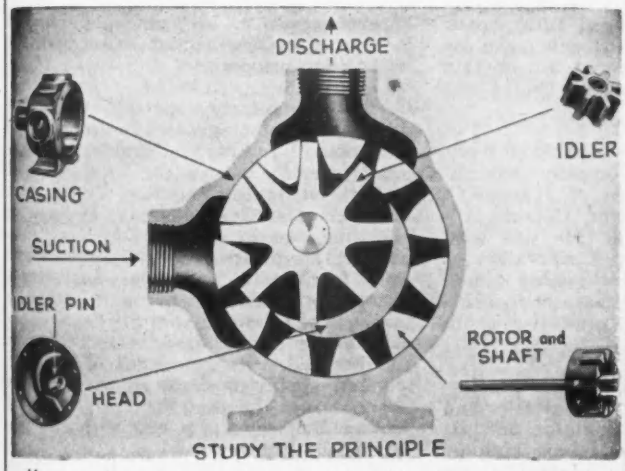
Viking Operating Principle




Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

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# What's Happening

## AMONG SERVICE AND SUPPLY MEN

F. M. Adams

J. W. Rockwell

Robert Hume

Homer A. Longino

S. Gerald Fuex

James F. Stewart

James Y. Oldshue

Gail Kilgore

Warren C. Dunn

William Krause, Jr.

Paul Azzolina

Robert B. Anderson

**Axelson Manufacturing Company**, Division of U. S. Industries, Inc., has announced the appointment of **F. M. Adams** as executive assistant. He will be responsible for the company's legal coordination, contract reviews and special assignments. Adams recently was transferred from the executive offices of U. S. Industries in New York where he served as assistant secretary of the corporation. **J. W. Rockwell**, recently appointed sales manager Hydraulic Unit division for Axelson, will be in charge of all sales of Axelson long stroke and hydrax hydraulic pumping units to the petroleum industry. He has, for the past 18 years, been with the company in the Mid-Continent oil fields.

**Weatherford Oil Tool Company's** promotion of **Robert Hume** from Southern district sales manager to export and Houston area sales manager has been announced. Succeeding Hume as district sales manager is **Homer A. Longino,** assistant Southern district sales manager. Hume has been with Weatherford six years. He was formerly a drilling superintendent with the Sinclair Oil and Gas Company in Venezuela. Longino has been with Weatherford since 1954.

**Southern Engine & Pump Company** has announced the appointment of **S. Gerald Fuex** as manager of sales promotion and advertising. Fuex formerly served as director of public relations and advertising for Trans-Texas Airways.

**James F. Stewart** has joined **Texsteam Corporation**, Houston, as sales representative in the Gulf Coast area. He will handle Texsteam's new separation and dehydration equipment. He formerly was with Maloney Crawford and Lane-Wells.

**Dr. James Y. Oldshue** advanced to the position of director of research, **Mixing Equipment Company, Inc.**, has been engaged in fundamental and applied research in fluid mixing since joining the company in 1950. Prior to his promotion he served as head of development engineering.

**Technical Oil Tool Corporation** announces that **Gail Kilgore** has been employed as a TOTCO service representative for the Victoria, El Campo and Refugio, Texas, areas. An experienced oilman, he will make his headquarters at Victoria and will operate under the supervision of the Gulf Coast division manager.

**Union Switch & Signal**—Division of Westinghouse Air Brake Company, has announced the appointment of **Warren C. Dunn** as assistant manager, General Apparatus Sales department. He was with the Thomas A. Edison Corporation as field representative before joining Union Switch & Signal as sales engineer in 1953. He was made supervisor, product sales, in 1954.

**McEvoy Company** announces the appointment of **William Krause, Jr.**, as sales and service engineer, serving Houston and the surrounding area. Krause joined McEvoy after serving as assistant plant engineer with an oil tool firm in the Houston area. Houston will be his headquarters.

**Paul Azzolina** is now manager of the Service department for the **Le Roi Division,** Westinghouse Air Brake Company. He formerly was assistant manager of the department. As manager, he will be responsible for supervising field servicing of all Le Roi products, maintaining the parts department, and publication of service bulletins and parts catalogs. He began with Le Roi in 1936 as catalog clerk.

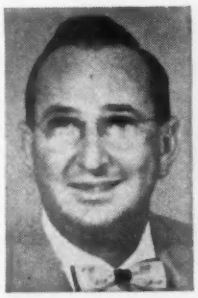
**Dresser Industries, Inc.**, recently announced the election of **Robert B. Anderson** to membership on Dresser's board of directors and to the company's executive committee. Anderson, recently named president of Ventures Ltd., a Canadian mining company, had a distinguished career in Washington as secretary of the Navy and Deputy Secretary of Defense. Prior to his government service, Anderson was attorney and general manager for the W. T. Waggoner Estate, in Vernon, Texas and in this capacity directed exploitation of its large oil property.

**C. E. Bills** recently appointed vice president and assistant general manager of all operations for **Empire Machinery Company,** formerly was on the executive staff of Parkersburg Rig and Reel Company as manager of systems planning. He also, at one time, was in charge of systems planning of all procedures of organization work for Dresser Industries, Inc. **Harris Sisson,** appointed vice president and sales manager of sales activities for Empire, has been active in all phases of the company and has had wide experience in the service and supply business in the Permian Basin during the past ten years. Prior to joining Empire, Sisson was with the National Supply Company.

**John S. Ryder,** now employe relations specialist for the Distribution Assemblies department of **General Electric Company,** will co-ordinate all department educational and training activities and will be responsible for maintaining an effective communications program. He also will coordinate all labor relations and wage administration programs. Ryder has participated in the company's employe relations development program since 1953. During this period, he has held training assignments in marketing, engineering, finance and manufacturing at various Company plant locations. He will make his headquarters at Plainville, Conn.

C. W. Kessinger

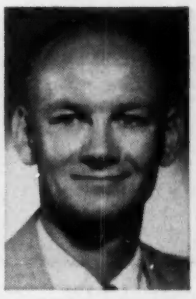
C. A. Yancey



W. A. Fox

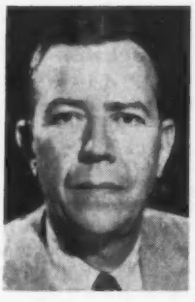
Vernon Goins

Charles Kromer



W. P. McIntyre, Jr.

Ben L. Hays



A. W. Rose

A. I. Aalto

A. Boyce Craig

Leon Daily

Robert H. Etnyre

**Warren M. Benson**, vice president **Alten Foundry and Machine Works, Inc.**, announces the appointment of **Charles W. Kessinger** as Alten representative in the Rocky Mountain territory with headquarters at Denver. Kessinger is an experienced oil field man formerly with Rowan Drilling Company and Bethlehem Supply Company.

**Tuboscope Company** has named **C. A. Yancey** district manager in Shreveport, a new district created in January, 1955. Yancey joined Tuboscope in 1951 in Odessa as a Sonoscope operator. After transferring to sales, he has worked in Abilene and New Iberia. **W. A. Fox** has been transferred to Oklahoma City as division manager for Oklahoma, Kansas and north Texas. A veteran of ten years with the company, he has seen service in Louisiana, Mississippi, New Mexico and Texas. **Vernon Goins** new division manager in New Iberia, La., joined the company in Oklahoma City in 1944. He was division manager there for eight years before his recent transfer. A new sales office has been opened in Denver with **Charles Kromer** as representative. Joining Tuboscope in 1951, he was transferred to Corpus Christi as a sales representative in 1955 where he was stationed until his transfer to Denver. A new sales office also has been opened in Dallas under direction of **William Penn McIntyre, Jr.** He joined the company in 1950, working on a Sonoscope crew in New Iberia, and took the first Sonoscope unit to Canada in 1952. In 1954 he moved to Houston as sales representative.

**Ben L. Hays** has been appointed manager of the Farmington, N. M., district office of **Welex Jet Services, Inc.** A veteran of five years of oil and gas well service work, he has been with Welex almost three years. Prior to transferring to Farmington, Hays was assistant manager of the Welex district office at Odessa, Texas. **Percy L. Hall**, appointed sales engineer for Wichita, Kansas, by Welex, has had 24 years experience in oil well service work, and has served as production superintendent, field superintendent, unit operator and drilling superintendent with both major and independent oil companies.

**A. W. Rose**, vice president of **Borg-Warner Corporation**, has been appointed vice president and general manager of the Petro-Mechanics Research Division. With the organization 24 years, Rose has served as vice president and assistant general manager of the Warner Gear Division, as Pacific Coast representative for the parent company, and as assistant to the chairman of Borg-Warner Limited, a subsidiary in Letchworth, England. In the Byron Jackson Division of Borg-Warner, **Philip W. Scott** has been named to the special post of assistant to the president. Scott has been an executive in Borg-Warner's headquarters at Chicago and had an important part in negotiating the recent merger between Byron Jackson and Borg-Warner. **W. O. W. Smith, Jr.**, has joined the company's Rockford Clutch Division as sales engineer and direct factory representative in the western oil fields, and **Donald R. Spotz** has been appointed general sales manager of the Pesco Products Division .

**A. I. Aalto**, named manager of plant facilities of **ALCO Products, Inc.**, will be responsible for facility engineering and requirements for the company's manufacturing plants, offices, warehouses and property. Having joined ALCO in 1951 as a tool engineer, Aalto has been supervisor of tool design, assistant superintendent of production and supervisor of machinery and tool design. Prior to his present appointment, he was Schenectady plant engineer.

**A. Boyce Craig** has been appointed director of public relations and advertising of the **Ingalls Companies**, including The Ingalls Iron Works Company, The Ingalls Shipbuilding Corporation and the Birmingham Tank Company. Formerly with McGraw-Hill Publications, where he served for 12 years as director of copy service, Craig also has been with Briggs Clarifier Company and the Ozalid Products division of General Analine and Film Company.

**Halliburton Oil Well Cementing Company** announces the appointment of **Leon Daily** as manager of Electrical Well Services for the company's Lubbock division. Previously EWS district superintendent at Duncan, Okla., he will maintain offices at Lubbock.

**Robert H. Etnyre** has been appointed plant manager of the Toledo plant of **The National Supply Company.** Starting with the company in 1946 as methods engineer at the Toledo plant, he subsequently was assigned to time study work, tool engineering, and plant accounting. He was appointed staff assistant to the works manager in 1952, and in that position was active in planning and construction of the company's plant at Gainesville, Texas.

**William H. Depperman** has been appointed to the new position of director of public relations of **Link-Belt Company**, assuming duties which previously had been assigned to Harlan B. Collins, secretary, who will continue to have corporate responsibility for the function. Depperman, formerly public relations director of Olin Industries, Inc., also has been with Steve Hannagan and with the Western Union Telegraph Company.

**Fairbanks, Morse & Company** has announced the election by the board of directors of **Robert D. Brown** as assistant secretary-treasurer of the corporation. Brown joined the organization in 1953, having been associated formerly with Richardson Company and International Harvester Company.

**Thermoid Company** recently announced the election of **Ronald S. Hulse** as vice president and general manager of Southern Asbestos Company, a Thermoid subsidiary. Hulse previously had been assistant to **George S. Fabel**, who in June retired as president of both Thermoid and Southern Asbestos after more than 35 years of service. Fabel is now acting in an advisory capacity. Prior to his employment with Southern Asbestos Hulse was with the Nebel Knitting Mills.

## Cabot Shops Completes Plant Building

**Aerial view of completed Cabot Shops, Inc., plant at Pampa, Texas, shows the newly-completed building providing an additional 43,000 square feet of floor space. The building, as well as other parts of the plant, are fitted with the latest equipment, including a hydraulic herring-bone gear cutting machine, one of the few made as yet by Ferrell-Birmingham Company, according to R. A. Baker, vice president and general manager. Baker also is president of the Franks division of Cabot Shops, Inc., at Tulsa.**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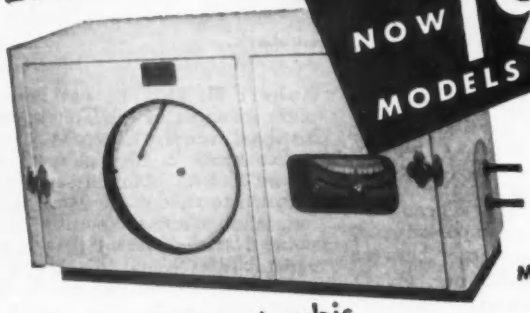

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**A. F. (Frank) Scarr,** appointed assistant to the vice president and general manager of **Kaiser Steel Corporation,** assumes the position left vacant by the appointment of **Jack J. Carlson** as vice president. Scarr joined Kaiser Steel in 1946 as procedures manager, and was appointed assistant controller two years later. In 1953 he was named assistant to the vice president in charge of operations and has rendered executive administrative assistance in that position since. He has been associated with the steel industry since 1937 when he joined Columbia Steel Company, now Columbia-Geneva Division of U. S. Steel.

**Earl W. Gettens** and **Merle M. Light** have been promoted to key accounting positions by **Rockwell Manufacturing Company.** Gettens, supervisor of headquarters accounting, has been named supervisor of accounting and budgets; and Light, assistant supervisor of headquarters accounting, has been made supervisor. Gettens joined Rockwell in 1946, became assistant supervisor of headquarters accounting a year later and supervisor in 1953. His earlier experience included more than 10 years of auditing and accounting. Light joined Rockwell in 1950 after seven years as senior accountant with Pressed Steel Car Company, Inc.

**Emsco Manufacturing Company** has announced the appointment of **Jack R. Bechtold** to head its mast and drilling structural sales. He will headquarter in the general sales offices in Dallas. For the past 6½ years Bechtold has been working in design and sales with the Lee C. Moore Corporation of Tulsa.

**Chicago Steel Tank Company,** division of U. S. Industries, Inc., recently appointed **Frederick F. Foltz** field erection manager. He will supervise crews engaged in the erection of on-the-site storage tanks and other structures contracted by the tank manufacturing firm. Foltz has been in the engineering and construction field since 1946.

**Wisconsin Motor Corporation's** appointment of **Tom Barrett** as assistant sales manager has been announced. A sales representative for the firm for the past seven years, he now will assist sales manager fellows in the further promotion of sales and distribution of Wisconsin heavy-duty air-cooled engines in the domestic market.


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## Great Lakes Carbon Forms Petroleum Service Subsidiary

A new corporation, Great Lakes Petroleum Services, Inc., with main offices in Houston, has been organized as a wholly-owned subsidiary of Great Lakes Carbon Corporation of New York City. The new firm will provide various electric wire line services such as perforating and gamma ray-neutron logging.

J. T. Hancock, Jr., is president of the new corporation; R. W. Smith is vice president-manager of sales and L. W. Toelke is vice president-engineering and development.

## Otis Pressure Control Opens Office in Hattiesburg, Miss.

Otis Pressure Control, Inc., Dallas, has opened a district office at 402 Dixie Avenue in Hattiesburg, Miss., to provide better service in an area of increased volume. Perry Spencer has been named wire-line-specialist-in-charge.

## Houston's Second National Bank To Be Bank of the Southwest

For the second time in its almost 50 years of existence, the name of the Second National Bank of Houston has been changed. The bank's new name, effective January 17, 1956, is "Bank of the Southwest National Association, Houston, Texas."

Founded April 15, 1907 by S. F. Carter, retired lumberman, as the Lumberman's National Bank, the institution's name was changed in January, 1923, to Second National Bank of Houston. The numerical "Second" in the name alluded to the bank's holding the second oldest national charter in the city at that time. It is now the oldest national charter.

## Acme Assumes Control Of Me-Tex Supply Company

Acme Oil Tool Company has assumed control of the Me-Tex Supply Company of Hobbs, N. M. The branch will be operated as Acme-Metex Tool Co., Inc. and will be managed by Don Burner. Burner has been, until recently, chief design engineer for the company. He formerly was with Skelly Oil Company.

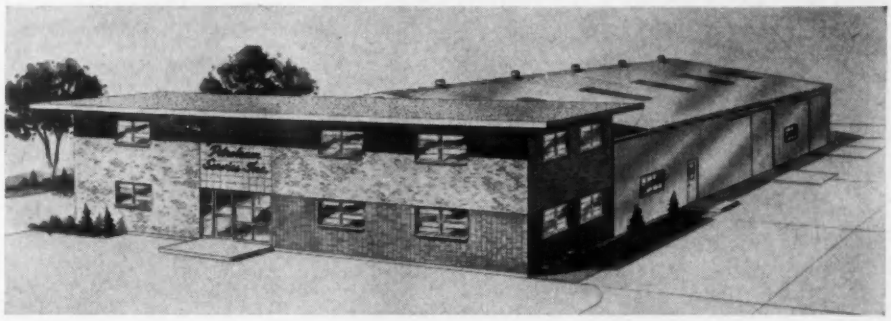
## H. K. Porter Company Acquires Two Concerns

The business of Henry Disston & Sons, Inc., has been acquired by H. K. Porter Company, Inc., in exchange for $6 million of preferred stock. Porter also has acquired the Monrovia, Calif., concern, Carlson & Sullivan, Inc., manufacturers of steel rules and measures, which will operate as part of the new Henry Disston Division, H. K. Porter, Company, Inc.

Lawrence L. Garber, a vice president of Porter, has been named general manager of the new division. Succeeding him as general manager at the Alloy Metal Wire division is Emmett Mann, presently sales manager of Alloy Metal Wire. Mann also has been elected a vice president of Porter.

The main Disston plant is on a 65-acre site along the Delaware river. The firm, which has five wholly-owned subsidiaries, is a manufacturer of saws, files, bar and sheet steel, hand and garden tools, machine knives, steel specialties and other allied products.

The Carlson & Sullivan firm will be known as Carlson Rules and Measures, Henry Disston Division, H. K. Porter Company, Inc. C. Vernon Newton has been appointed Carlson's plant manager and George F. Beebe, controller.



**A new wire-line service company will begin operations in the Gulf Coast region this month when Great Lakes Petroleum Services, Inc., opens its new building on Robin Road, Houston. The plant will include administrative offices, electronic laboratories, equipment proving areas and shop facilities for design and assembly of wire-line tools.**

## Baroid Uses Specially-Designed Drilling Mud Delivery Vessel

Baroid Division of National Lead Company has adapted the U. S. Navy method of fueling at sea to the delivery of drilling mud to offshore operations by use of a specially-designed barge. The vessel basically is an ocean-going vessel with a pay load capacity of 1500 tons of mud. It is 196 feet by 42 feet by 13 feet and can carry 600 tons of fresh water and 100 tons of diesel fuel for emergency delivery to offshore drilling rigs in addition to its mud capacity.

The vessel is towed to offshore locations, then released by the tug and maneuvered into delivery position with the aid of anchors, winches and special propulsion equipment. After the barge is anchored by the rig, a messenger line with a 4-inch rubber hose stoppered to it is shot onto the platform or tender. End of the hose goes into the dry bulk mud storage bins on the rig. Working fore and aft through the storage hopper on board is a dragline bucket which gathers the bulk material to a pneumatic pump in the engine room at the aft end of the barge. The pneumatic pump aerates the dry material and pumps it through the hose into the storage tanks of the rig. Bulk material can be pumped more than 200 feet.

## U. S. Steel Establishes Oilwell Store In Kentucky

Oil Well Supply Division of U. S. Steel announces the opening of a new store at Beattyville, Ky. The store will maintain stocks of drilling and production materials and supplies as required by the increasing activities in central and eastern Kentucky.

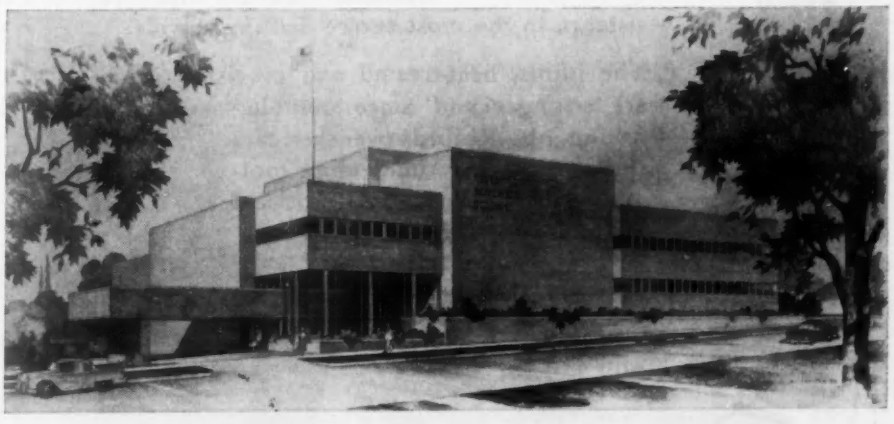
James A. Durham will be manager of the store. Employed in 1941 at Irvine, Ky., he was transferred to Charleston, W. Va., in 1948, and in 1950 became manager of the Charleston store. In 1953 he was appointed district representative at this location.

## Cardwell Manufacturing Bought by John Mecom

John W. Mecom, Houston independent oil operator, has bought all assets of the Cardwell Manufacturing Company, Inc., pioneer manufacturer of drilling and service equipment. Mecom has assumed the responsibility of all operations. Purchase price was not disclosed.

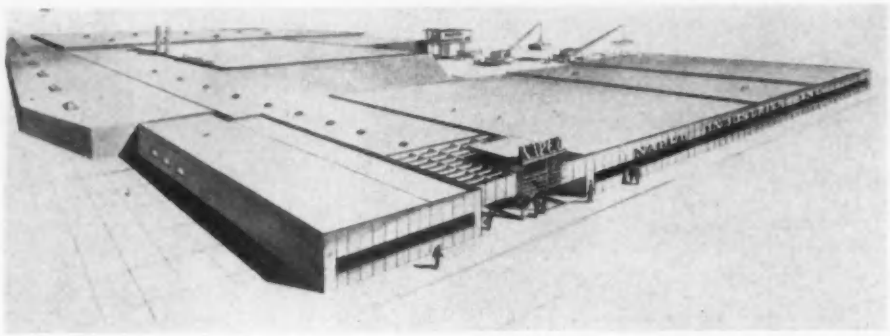
The organization will continue under the name Cardwell. All employes will be retained with the exception of H. W. Cardwell, president, and Mrs. M. H. McKee, vice president and treasurer, who have asked to be relieved of their responsibilities.

Mecom operates 20 drilling barges and rigs on his own properties. He also owns a third interest in a drilling project in Louisiana which set a new world's record for depth.



## *Fisher Governor Moves into New Center*

**Fisher Governor Company has moved into its recently completed research and engineering center in Marshalltown, Iowa. The new three-story brick structure has 100,000 square feet of space and covers approximately half a square block. The enlarged product engineering department is adjacent to the research laboratory area. Sales engineering, executive offices and general office departments also are in the new building.**



An artist's conception of the new Napco Industries, Inc., plant in Minneapolis shows the more than 1 million square feet of storage and manufacturing space providing ample room for the company and its five manufacturing and service divisions. Of concrete and steel construction, the plant is served directly by spur lines from two railroads and is close to main highways and barging facilities on the Mississippi river.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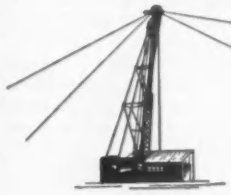

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## Napco Moves Truck Division From Detroit to Minneapolis

"F" Day will be celebrated this month by Napco Industries, Inc., to mark formal opening of its Federal Motor Truck division, whose facilities have been moved from Detroit to a new plant in Minneapolis.

The Federal Motor Truck Company, Detroit's oldest truck manufacturing firm, was merged into Napco in March, 1955. The original Federal Motor Truck Company was organized in 1910.

More than 3000 tons of equipment and machinery will be moved from Detroit to the new plant site, including such items as huge cab-welders, overhead cranes, jugs and other fixtures and thousands of miscellaneous tools. More than doubling its present capacity, Napco's new plant will provide 1 million square feet of space for production facilities, office and storage when completed.

## Jones & Laughlin Breaks Ground For $1.5 Million Office Building

Jones & Laughlin Steel Corporation, Supply Division, broke ground recently for a $1.5 million Tulsa headquarters building. The new building is part of the current expansion and improvement plan of the nation's fourth largest steel producer. To be modernistic brick with more than 100,000 square feet of floor space, the building will consist of an air-conditioned office and a large warehouse with a file storage area in the basement. The structure is expected to be completed and ready for occupancy by the division's 300 employes in September, 1956. The building will front on Sheridan Road and will parallel 15th Street.

## New Firm to Conduct Research On Jet Charge Perforating

Formation of a new corporation, Jet Research Center, Inc., has been announced jointly by Welex Jet Services, Inc., and the Byron-Jackson Division of the Borg-Warner Corporation. The new corporation, to be jointly owned by the two parent companies, will occupy the laboratories and testing facilities of the former Welex Research Center in Arlington, Texas.

B. M. Caldwell, formerly Welex vice president for engineering, will be president of the new company. Members of the board of directors will be Ray Shaffer and T. W. Painter of Welex, and Robert Marcus and A. E. Hambly of Byron-Jackson. The five also will form the company's technical committee.

Jet Research will conduct original research on jet charge perforating for the two companies, and work will be performed to extend the use of jet process to other industries. The company also will operate as a manufacturing concern, and will be engaged in the manufacture of jet charges and all former Welex tools where explosives are a component part.

## Knight-Gordon Engineering To Represent Aldrich Pump

The Aldrich Pump Company announces the appointment of the Knight-Gordon Engineering Company of Tulsa as their representative for Oklahoma, Kansas and Arkansas.

Knight-Gordon is headed by A. H. Knight, formerly with The Cardell Manufacturing Company, and M. J. Gordon. They will carry complete stocks of parts for Aldrich pumps.